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ABSTRACT

Offering an historical perspective on the development of science, engineering, medicine, and technology and providing current role models for minority students, the bulletin lists the outstanding contributions made by: (1) Blacks - medicine, chemistry, architecture, engineering, physics, biology, and exploration; (2) Hispanos - biomedical research, botany, biology, physics, chemistry, space education, physiology, mathematics, pharmacology, meteorology, oceanography, sociology, geology, anthropology, psychology, engineering, electronics, and computers; (3) Asian Americans - astronomy, engineering, technology, mathematics, medicine, health, physics, dentistry, chemistry, and space education; (4) American Indians - engineering, botany, physics, architecture, chemistry, biology, agronomy, forestry, environmental science, weather forecasting, science education, audiology, otolaryngology, archeology, nursing, mathematics, anthropology, psychology, dentistry, medicine, and pharmacology. Also listed are Hispanic Nobel Prize winners, scientists of the 20th century, and professors; Moslem and Jewish scientists of Medieval Spain (circa 900-1400), statistics on the representation of Hispanos in science; programs designed to meet the Hispanos' health service needs; programs for Indian students and agencies to contact for possible financial aid; groups of special interest to Indian students; and available resources and creative ways to incorporate knowledge and appreciation of minority contributions into the regular instructional program. (NQ)

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MINORITY CONTRIBUTIONS TO SCIENCE, ENGINEERING, AND MEDICINE

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San Diego City Schools
San Diego, California
1978

MINORITY CONTRIBUTIONS

TO SCIENCE, ENGINEERING, AND MEDICINE

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San Diego City Schools
San Diego, California
1978

PREFACE

Only about five percent of the scientists and engineers in the United States are minority members and, as a result, few role models for these professions are available to our students. Moreover, until recently, little has been written or taught about the valuable contributions which minorities have made to science, engineering, and medicine.

Because it is estimated that not even 10 percent of minority college entrants are adequately prepared--or motivated--to seek degrees in these fields-- it is especially important that minority students showing interest in or aptitude for the sciences be advised (by junior high at the latest!) to concentrate on mathematics, science, and the language arts when choosing their high school courses. It is equally important that they--and their classmates--become more aware of the role played by minorities in the development of our scientific and technological society.

This Instructional Suggestions Bulletin is planned as a resource to help science teachers and counselors assist and advise students making academic and career choices. It offers an historical perspective on the development of science, engineering, and medicine and the outstanding contributions made by minority groups. It also provides current role models (local as well as worldwide) for minority students.

Attention is directed to the special teacher's section which lists available resources and suggests creative ways to incorporate knowledge and appreciation of minority contributions into the regular instructional program.

Users of this bulletin are encouraged to send criticisms or suggestions for improving this publication to the Science Specialist, Programs Division.

Elisa L. Sanchez
Assistant Superintendent
Programs Division

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BLACK CONTRIBUTIONS TO SCIENCE, ENGINEERING, AND MEDICINE

Prepared by

Peggy Funches

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IMPORTANCE OF RECOGNIZING THE CONTRIBUTIONS OF BLACKS

In the past, Blacks were often told that science was too difficult for them, that only a few exceptional Blacks had ever achieved--or could achieve--success in this field. Science and history books made little mention of their discoveries and inventions and, as a result, too few Black students learned about the contributions that members of their race have made to the world of science.

Today's Black students should be given the opportunity to study about these individuals and learn about their contributions. This can be accomplished by counselors who take the time to emphasize to Black students the importance of the academic sciences, and by teachers who make an extra effort to encourage the participation of minority students in the study of science. Science is an establishment that is truly committed to equality for all people. Failure to teach the accomplishments of any race is a great disservice to the members of every race.

HISTORICAL AND CONTEMPORARY ROLES OF BLACKS

Evidence of the long march of Black history can be found from the Olduvai Gorge to the Sahara Desert. Archeological findings and the dating of fossils indicate quite strongly that East Africa was the cradle of humanity, that it was here that the world's first people made their appearance approximately one and three-quarter million years ago. Here, too, it is believed, was the original home of our more remote ancestors whose origins can be traced back twenty-five million years to the Lower Miocene epoch.

These discoveries point, also, to the likelihood that the use of tools spread from here--where stone implements for chopping and cutting were made over two and one-half million years ago--to the countries of Europe and Asia. During the three periods of the Stone Age, a number of progressively sophisticated tools--from all-purpose hand axes to scrapers, picks, cleavers, choppers, etc.--came into use. (In the rain forests, for example, heavier tools were needed for chopping, as were finer ones for wood carving.)

Other inventions dating from 30,000 to 100,000 years ago include tool handles and the use of fire. Spears for fishing probably came next, as did boat building; the use of pigments to make paint (for rock and wall drawings and to decorate the body; the making of stone and bone knives and fishhooks; and paintings which clearly depict a mixed African-Egyptian culture. In their paintings, the pre-dynastic Egyptians often pictured themselves as having skins of black, reddish-brown, or yellow. Scholars who have examined some 800 skulls discovered that while many were a mixture of Semetic and Caucasian stock, at least one-third were Negroid. It is generally conceded that Africans were the first to discover, extract, and refine iron. The people of the ancient Kush culture (which is regarded as heavily influencing that of Egypt)

made their country and especially its capital, Meroë, a center of iron-working. It is here (Ethiopia of the Bible) that civilization reached its highest level in the years from 250 B.C. to 100 A.D. These people smelted the iron, using blast furnaces that operated on the basic principles of those of today, and fashioned it into such items as spears and hoes.

The remains of blast furnaces (constructed of densely packed, heat-retaining earth taken from the giant ant-hills of that country) can be found throughout much of Africa. Mining (via shafts up to 80 feet in depth) and working of gold were also common; skilled craftsmen used this precious metal to make both ingots for trade and fine, ultra-thin gold plate for decoration. Alloys of copper and tin and other metals were made. Sculptures were cast by pouring molten metal into wax-lined molds (the was melted and flowed out of holes in the mold). Egyptian craftsmen also made paper from reeds; tooled leathers; fashioned fine cloth, jewelry, metalware, pottery, and furniture; and designed temples, palaces, and pyramids.

Excavations in the Valley of the Nile have shown that Stone Age Blacks made pottery earlier than did the residents of the world's first city. It is known that much later, the people of Kush, who excelled at pottery making, ground colored earth to make pigments with which to decorate their work.

Credited with being the first to learn about the planetary system, early Africans took the initial steps towards developing this science which became especially popular in Egypt, a civilization that Blacks helped build over 6,000 years ago.

They employed irrigation, plowing, hieroglyphic writing, calendars, embalming, and a decimal number system. The Egyptian words for 1, 2, 3, 4, 5, and 10 are of African origin; those for 6, 7, 8, and 9, Semetic--indicating that their root language was African and that their number base was 5. It was here, too, that one of the earliest forms of cursive writing was developed; a form which even now has been only partially deciphered.

The early Africans, who were much given to classification, used criteria that reflected their needs and conditions--and which could be applied to their grazing and farming practices. They listed grasses by their grazing value; rocks and soils by their water-bearing capacities (soils also by their ability to grow crops and rocks by their mineral content); plants by the seasons (wet or dry) in which fruit was borne; animals by their habits; and clouds by their relationship to the weather. The knowledge acquired in this way enabled them to develop the best farming techniques for each area (forests, open woodlands, and grasslands); facilitating crop growth by making full use of natural conditions and the traits of different plants. Sensitive plants were sheltered from the sun and natural drainage utilized (as was the natural compost created by falling leaves). In areas with poor soil, a land rotation system was used and cattle manure and wood ash were employed as fertilizers. The independent evolution of agriculture, uninfluenced by that of other cultures, occurred first in West Africa. Wheat, barley, millet, and rice became the staple foods and, much later, were supplemented by a number of foreign crops.

The medicine men of the Belgian Congo used (and still use) Rauwolfia (from which Reserpine, a tranquilizing drug used for treating hypertension and mental disease, is made) for various nervous and mental ailments. In the early days of America, many slaves learned to use herbs, black roots, witch hazel bark,

pine sap, and bones as cures for sore throats. Those slaves also used mustard and soft soap mixed with sugar to draw boils, "risings", and suppurations to a head. Moistened clay and tobacco were used for treating insect bites and stings. Castor oil was a favorite treatment for a number of ailments and sassafras tea was a specific for thin blood. Many of these folk medicines are still popular with Blacks.

Over the years, Blacks have made many valuable contributions in the fields of science, medicine, and engineering. The following capsule summaries tell the stories of some of these outstanding Blacks.

MEDICINE

Dr. Caroline Anderson (1849-1919), a physician and educator, was one of two Black women pioneers in the field of medicine. A graduate of Oberlin College, she became a teacher of music at Howard University. She studied medicine there and at the Women's Medical College in Philadelphia, the city where she later established a practice.

Dr. W. Montague Cobb (1904-), physician, anatomist and anthropologist, was born in Washington. He earned several college degrees (A.B. Amherst College; M.D. Howard University; Ph.D. Western Reserve University; Sc.D. Amherst, and LL.D. Morgan State College) and taught at Howard, Catholic University of America, and Western Reserve. The recipient of the Selective Service Medal (Congress), the Meritorius Public Service Award (Government of D. C.) and the Distinguished Service Medal (National Medical Association, of which he was a past president), he worked to eliminate segregation in the fields of hospitalization and health. As editor of the *Journal of the National Medical Association*, he devoted much time to writing articles condemning the abusive way Blacks were treated and was instrumental in forcing the American Association of Anatomists and American Association for the Advancement of Science to not tolerate having such abuses imposed on their Black members. Among his many contributions were studies on the development of a graphic method of learning anatomy; on the suprasternal bones in man; the physiological anthropology of the American Negro; age changes in the adult human skeleton; and the dentition of the walrus. He also demonstrated the craniofacial union in mammals and man.

Dr. Austin Curtis (1868- ?) was the first Black physician to hold a position on the Cook County Hospital staff. In 1898 he was appointed Surgeon-in-Chief of Freedmen's Hospital, Washington, D. C., where he worked for four years before leaving to go into private practice. As associate professor of surgery, he taught science at Howard Medical School.

Dr. Ulysses G. Dailey (1885-1961), a surgeon, was born in Donaldsonville, Louisiana. He graduated from Northwestern University Medical School in 1906, then studied in London, Paris, and Vienna. In 1926 he established his own hospital in Chicago. He was an associate editor (and later editor-in-chief) of the *Journal of the National Medical Association*, a founding Fellow of the International College of Surgeons, and a United States State Department health advisor to countries throughout the world.

Dr. Martin Delaney (1812-1885) was born the son of free parents in Charleston, West Virginia. He studied medicine with a private physician but lack of money forced him to take up a career in journalism. He later returned to medicine, enrolling in Harvard Medical School in 1847. After earning his degree, he went on to become an outstanding doctor and the first Black major (in the U. S. Colored Troops) of the Civil War. After the war he served as a customs inspector, trial justice, and lieutenant governor of South Carolina.

Dr. James Derham (1762- ?), who was born a slave in Philadelphia, is generally recognized as the first Black doctor in America. After learning his profession as assistant to a physician master, he, in 1783, bought his freedom and proceeded to build a practice among people of all races. By 1788 he was considered to be the leading physician in New Orleans.

Dr. Helen Dickens (1909-) in 1950 became the first Black woman to be admitted to the American College of Surgeons. A specialist in obstetrics and gynecology, she was voted Philadelphia's Woman of the Year in 1960.

Dr. Charles Drew (1904-1950), the son of a carpet layer and a teacher, had extraordinary ability in both scholarship and athletics. At Amherst he won the Mossman Trophy for his outstanding contributions to the college. A graduate of McGill University Medical School in Montreal, he taught pathology at Howard University and was the director of the first plasma division of the Blood Transfusion Association (supplying plasma to Britain in 1940-41) and was the first director of the American Red Cross Blood Bank (supplying plasma to U. S. forces). His research led him to discover a method for preserving blood for up to seven days and more importantly, to derive a way to preserve plasma and dry plasma for use at a later time. He might have done much more work along these lines had not problems involving the donation of blood from Blacks to whites arisen. An outstanding teacher, he was also the recipient of the Springarn Award and director of the Washington, D. C. chapters of the National Foundation for Poliomyelitis and the Society for Crippled Children.

Dr. William Hinton (1883-1959), an expert on venereal disease, developed the Hinton test, a reliable method for detecting syphilis. Born in Chicago, he received his medical training at Harvard. For three years he was a voluntary assistant in the pathological laboratory at Massachusetts General Hospital, then did eight years of laboratory work at Boston Dispensary. He became an assistant lecturer in preventive medicine at Harvard University, where, in 1949, he was the first Black to be granted a professorship.

Dr. Jane Wright Jones (1919-), daughter of Dr. Louis Tompkins Wright (see entry), works in cancer chemotherapy research. For twelve years she directed an experimental drug treatment program for cancer patients at New York University Medical Center. She has written many articles on the treatment of carcinoma and melanoma and, in 1964, was appointed to the President's Commission on Heart Disease, Cancer and Strokes.

Dr. Theodore Lawless (1892-), one of the world's foremost skin specialists, was born in Thibodeaux, Louisiana. He was educated at Talledega College in Alabama, the University of Kansas, Columbia, and Harvard and received his M.D. from Northwestern. He taught at Northwestern's School of Medicine from 1924 to 1941 and later did research in Europe, making important contributions to the treatment of syphilis and leprosy. Thanks to his efforts, the dermatology

clinic at Beilinson Hospital Center in Israel, which is named after him, became a reality. He won the Harmon Award for medicine in 1929 and the Springarn Award in 1954.

Dr. Delanc Meriwether (1943-), a physician specializing in blood diseases, was the first Black to be accepted into the Duke University School of Medicine. An excellent athlete, he was a world class sprinter in the 100 yard dash as well as shorter distances. Meriwether won a U. S. Public Health Service Award for co-authoring a paper entitled "The Inhibiting of DNA and RNA Synthesis by Daunorubicine and Adriamycin in 1-1210 Mouse Leukemia." In 1976, he headed the nationwide swine flu innoculation program.

Dr. Percy J. Russell (1926-) of New York City is the Assistant Dean of the School of Medicine, University of California at San Diego. A graduate of the College of the City of New York (B.S. chemistry), Brooklyn College (M.A. organic chemistry), and Western Reserve University (Ph.D. biochemistry), he has been a research assistant at the Sloan-Kettering Institute for Cancer Research in New York; a Harvard University research fellow, and taught in the Biochemistry Department of the University of Kansas Medical Center and the Department of Biology at U.C.S.D. A member of Sigma Xi and the Society of American Biological Chemists, Dr. Russell has been widely published in the areas of enzymatic mechanisms, immune chemical mechanisms, and iso enzymes.

Dr. Daniel Hale Williams (1856-1931) was born in Holidaysburg, Pennsylvania. He went to work at the age of twelve and at seventeen became a barber. He studied with a tutor, then apprenticed himself to a doctor who had been one of his customers. After graduation from the Chicago Medical College (he also took a LL.D. from Wilberforce University), he became a member of the surgical staff at the South Side Dispensary and an instructor at the college. Dr. Williams helped plan and build the interracial Provident Hospital and Training School Association, established a nurses' training program which admitted Blacks, and was one of the founders of the National Medical Association for Black doctors. He published many articles and is credited with the first successful closure of a stab wound to the heart and pericardium.

Dr. Louis Tompkins Wright (1891-1952) of LaGrange, Georgia, graduated from Clark College and Harvard Medical School. He was the first Black to be appointed to the staff of New York Municipal Hospital; the first to join the American College of Surgeons; the first to be a surgeon in the police department of New York; and the first to head an interracial hospital. The first doctor to experiment with Aureomycin and Terramycin on humans, he published 38 papers dealing with these drugs. The youngest surgeon to be put in charge of a base hospital, he also introduced the use of interdermal smallpox vaccinations in the Army. He invented a neck brace for fractures that is still in use today.

MEDICAL SCIENCE

Margaret Bailey, a nurse who was born in Mobile, Alabama, was the first Black to become a lieutenant in the Army Nurse Corps. After the death of her father she worked on weekends and after school to support her family. Upon finishing high school she worked for three years before attending the Fraternal Hospital School of Nursing in Montgomery. She worked in Florida and New York before

joining the Army and caring for prisoners of war in Florence, Arizona. She later received her B.A. in nursing and, in 1959, went to France as chief nurse *of the 130th General Hospital.*

CHEMISTRY

Dr. George Washington Carver (1864-1943), who was born a slave, never knew his parents. As a child he was given the job of collecting bark to brew as medicine. When slavery was abolished, he left his owners, the Carvers, and went to school. After attending Simpson College and Iowa Agricultural College (where he finished at the top of his class), he became the first Black to serve on the Iowa Agricultural College's faculty. In 1896 he became director of the Department of Agricultural Research at Tuskegee Normal and Industrial Institute in Alabama. Dr. Carver's research enabled him to make 300 products (dyes, soap, cheese, milk substitutes, instant coffee, bleach, paper, linoleum, plastics, etc.) from peanuts; 118 from sweet potatoes; 75 from pecans, and hundreds from such waste products as corn stalks. He made dyes and talcum powder from local clays and taught the importance of soil improvement and diversification of crops. His discoveries revolutionized southern agriculture by showing the South that it no longer needed to be dependent upon cotton.

Dr. Lloyd A. Hall (1894-), an industrial chemist who was born in Elgin, Illinois, and educated at Northwestern, the University of Chicago, and the University of Illinois, received over 25 patents involving the preservation of meats and foods containing oils and fats, the sterilization of spices (to destroy the yeast, molds, and bacteria which too often grew in them), and the curing of other food products. He held a variety of important positions before going to the Griffith Laboratories where he stayed for 34 years and accomplished his most valuable work.

Dr. Percy Lavon Julian (1898-), who was born in Montgomery, Alabama, went to a public school for Blacks and then to a small state teachers' school. In 1916 his father sent him to DePauw University where he majored in chemistry; while there, he carried a double load of classes to make up for the deficient education he had received in Alabama. After graduation (he was the class valedictorian and a member of Phi Beta Kappa) he taught at Fisk University for two years, then won a fellowship to Harvard, where he received his M.A. in 1923. After earning this degree, Julian taught at West Virginia College and Howard University. He was awarded a fellowship to study chemistry in Vienna and there received his Ph.D. (He was later to receive an impressive number of honorary degrees.) He then became famous for synthesizing physostigmine, which was effective in treating glaucoma. As an industrial chemist and director of research of the Soya Products Division of the Glidden Company, his achievements included the extraction of soya bean protein to produce aero-foam for use in extinguishing fires. He did research on indoles, amino acids, an anti-fatigue drug, and synthesized progesterone, testosterone and cortisone (which is used in the treatment of arthritis). Cortisone is an expensive drug; Dr. Julian's soya bean synthesis put it within the price range of the average citizen. He was later president of his own company, Julian Laboratories (also Laboratorios Julian de Mexico and Julian Research Institute), which eventually merged with Smith, Kline and French Pharmaceuticals in a move that made him a very wealthy man.

Dr. Ernest Just (1883-1941), who was born in Charleston, South Carolina, went to a public school for Black children, then studied at Kimball Academy in New Hampshire. After graduating with honors, he entered Dartmouth College, where he became interested in embryology and graduated as the only magna cum laude in his class. He spent his summers doing research at the Marine Biological Laboratories in Massachusetts. After earning his Ph.D. at the University of Chicago, he did research, taught at Howard University, and published over 60 papers. He became an authority on the embryological development of marine animals, showed that the cytoplasm was important in cell function (and in the process changed scientific opinion about life itself), and that fertilization was a reaction between the spermatozoon and the ectoplasm of the egg. He was associate editor of the *Biological Bulletin*, the *Journal of Morphology*, *Physiological Zoology and Protoplasma*, a researcher at Kaiser Wilhelm Institute of Biology in Berlin, the Sorbonne in Paris, and the Naples Zoological Station in Italy, and was honored throughout the world (though not, unfortunately, in his own country). He published three books--(with others) *General Cytology*, *The Biology of the Cell Surface*, and *Basic Methods for Experiments on Eggs of Marine Animals*.

Joseph W. Watson Ph.D. (1940-), was born in New York City and graduated from City College of New York and the University of California, Los Angeles. Provost of Muir College at the University of California, San Diego, he previously taught in that school's department of chemistry. A member of many professional and affirmative action groups, he is also involved in research on nucleophilic substitution reactions and inter- and intra-molecular catalysts (fields in which he has been widely published).

ARCHITECTURE

Hilyard R. Robinson. An architect who studied at the University of Pennsylvania, Columbia University, and the University of Berlin, Mr. Robinson is best known for his work on the Langston Public Works Administration Housing Project for Negroes. The winner of several prizes for his architectural designs, he planned the historic restaurant at the Henry Hudson Hotel in Troy, N. Y., and the Men's Dormitory at Howard University. A professor and department chairman at Howard for 13 years, he also served as consultant to the National Capitol Advisory Committee and was senior architect for the U. S. Suburban Resettlement Administration.

Paul R. Williams (1894-). Born in Los Angeles, California and educated at the University of Southern California, Mr. Williams, who favors putting houses into their surroundings, designed the homes of many famous movie stars as well as a variety of buildings in his home town (including the Shriner Auditorium and the First Methodist Church).

INVENTION AND ENGINEERING

Mrs. Gwendolyn Keal Albert, M.S. (1949-), a staff engineer for the U. S. Army Corps of Engineers' Water Supplies Branch in Dallas, Texas, conducts studies to determine the water supply needs of southwestern communities. She makes suggestions regarding the future development of water resources in those

areas. A graduate of Southern University in Baton Rouge, Louisiana and Stanford University in Palo Alto, California, she has a B.S. in chemistry and a M.S. in civil and environmental engineering. Her work is particularly important in view of America's growing water and energy problems. On her findings and recommendations may rest the orderly growth, future well-being, and industrial development of many American cities.

Archie Alexander (1887-1958) graduated from the University of Iowa with a B.S. in engineering. In two years he was the foreman of a bridge construction company and in 11 years was the head of his own company. He has completed contracts worth over five million dollars and has built a million-dollar heating plant which required tunneling under the Iowa River. One of the most prominent engineers of his time, he was the recipient of an honorary degree for his achievements.

Benjamin Banneker (1731-1806), who was born on a farm outside Baltimore, Maryland, attended a Quaker school that opened in his community. After seeing a watch for the first time, he carved from wood what is believed to be the first clock made in the United States. (It worked perfectly for more than 20 years.) He also built a mill, advocated the rotation of crops, made a mathematical study of the life cycle of the 17-year locust, and wrote a treatise on bees. The publisher of an annual almanac (the first scientific book by a Black American) which contained tide tables, eclipse information, etc.,he also did the surveying that made possible the building of the city of Washington.

Henry Blair (1804-1860) was probably the first Black to receive a U. S. patent; he was granted one in 1834 for the invention of a corn planting machine and another in 1836 for his cotton planting device.

Andrew Beard (c.1850-1910) invented a safe and automatic way to couple railroad cars, a job that had been done by hand, causing many injuries to the workers. He became wealthy after selling this invention for $50,000. He also patented a rotary engine.

David Crosthwait (1898-), who was born in Nashville, Tennessee, received both a B.S. and an M.S. in engineering from Purdue University. In 1920 he invented and patented an automatic water feeder; in 1921 an automobile indicator; in 1928 a thermostat setting apparatus; and in 1929 and 1930, he patented a vacuum heater and pump. He also helped develop the machinery and method used to heat the 70-story Radio City Music Hall.

James Forten was one of the first Black inventors on the American scene. He invented a method of sewing sails and eventually bought out the business where he worked. He did much to aid Blacks in their struggle for their rights.

Frederick McKinley Jones (1892-1961). Mr. Jones, who was born in Cincinnati, Ohio, was orphaned in early childhood and raised by a priest in Covington, Kentucky. A mechanic, he was responsible for many important inventions, one of which was the first mechanical refrigeration system for trucks and trains (which made possible the low-cost transport of frozen foods). He also developed a portable X-ray machine, an air-conditioner for military field hospitals, a refrigerator for field kitchens, a self-starting gasoline motor, and the machine used in theater box offices to release tickets and return change. The holder of 61 patents, he was the first Black member of the American Society of Refrigeration Engineers.

Lewis Howard Latimer (1848-1928), who was born in Chelsea, Massachusetts, served in the Navy during the Civil War. A draftsman and electrical engineer, he drew the sketches used on Alexander Graham Bell's application for the patent(s) on the telephone. He worked for the United States Electrical Lighting Company in Bridgeport, Connecticut, conducting experiments which led to the improvements in the incandescent electric light. In 1884 Latimer joined the Edison Electrical Company. While there he wrote the standard book on the mechanics of the electrical light.

Jan Matzeliger (1852-1889), who came to America from Dutch Guiana, revolutionized the shoe industry with his invention of a machine to last shoes (attach the tops of the shoes to the bottoms). He sold this invention to the Sydney Winslow Company and, as a result of his genius, the price of shoes fell by 50 percent while workers' wages doubled. This invention, made by an uneducated man, was so complicated and sophisticated that it took 10 years to perfect and was impossible for the patent attorneys to understand.

Elijah McCoy (1844-1928), who was born in Canada and educated in Scotland, invented the automatic lubricating cup which made it possible for machines to be lubricated while in use. Before this, all machines and work had to stop in order to lubricate the equipment. He held over 50 patents, all but two of them having to do with automatic lubrication. These inventions were so important that purchasers would not accept heavy-duty machines made without McCoy's automatic lubricating devices. "Is it the real McCoy?" they would ask, and that, it is said, is the origin of this popular description of perfection.

Garrett A. Morgan (1877-1963) was born in Paris, Kentucky. His first invention was an improved sewing machine, which he sold for $150. Morgan became famous when he used his "gas inhalator" to rescue several men trapped in a tunnel 200 feet below the surface of Lake Erie. (This invention later evolved into the gas mask used in World War I.) He later invented the automatic electric stop light, for which General Electric paid him $40,000.

Norbert Rillieux (1806-1894), a machinist and engineer from New Orleans, Louisiana, who studied and taught in Paris, invented the vacuum evaporating pan which revolutionized the sugar refining methods of his day. His first successful evaporator was installed at Myrtle Grove Plantation in Louisiana in 1845. His system was later adapted to other industries such as the manufacture of glue, soap, and gelatin, and adopted by other countries.

Lewis Temple (1800-1854), a metalsmith, who was born in Richmond, Virginia, modified the whaling harpoon and manufactured a new one that allowed lines to be securely fastened to the whale. This toggle harpoon so improved whaling methods that the New England whaling catch doubled. He never patented his inventions and, as a result, died in poverty.

Granville T. Woods (1856-1910), of Columbus, Ohio, held the patents on 50 inventions. Among these were the automatic air brake, a steam boiler furnace, an improved telephone transmitter, an incubator, and the induction telegraph which, by allowing communication between moving trains, helped avert railway accidents which were a major concern of that time. Once an engineer on the British steamer, *Ironsides*, he also worked for a rolling mill and drove a steam locomotive for the D & S Railroad.

PHYSICS

Dr. Edwards A. Bouchet, the first Black awarded the Ph.D. by an American University, received this degree in physics from Yale University in 1876.

George E. Carruthers, Ph.D. (1940-). Dr. Carruthers, who was born in Chicago, Illinois and earned his Ph.D. in physics at the University of Illinois, is one of the two designers of the Apollo 16 lunar surface ultra-violet camera/spectrograph. Placed on the moon's surface in 1972, it gave the world the first photos of the ultra-violet equatorial bands of atomic oxygen circling the earth.

NATURALISTS AND BIOLOGISTS

Dr. Leon Roddy (1921-) majored in biology at Texas College, a Methodist-supported institution in Tyler, Texas. He was a student assistant in biology and held many other jobs. After going into the Army, he returned to receive his Ph.D. in biology from Ohio State University. He is now a professor at Southern University in Louisiana, where he started his study of spiders, and has worked with the U. S. government in locating and identifying poisonous varieties. He has also identified thousands of spiders for scientists from all over the world. Thanks to his identification of the spiders that bit them, the lives of countless numbers of people have been saved.

Dr. Charles Henry Turner (1861-1923) attended the University of Cincinnati. He then taught school and served as an assistant in biology at the University. Later, while a professor at Clark College in Atlanta, Georgia, he discovered that insects respond to colors as well as to odors. In studying the ant lion, he found that it could lie motionless from terror paralysis. Many of his observations on these and other insects were later published in the *Biological Bulletin*. He earned his Ph.D. at the University of Chicago.

EXPLORERS

Matthew A. Henson (1866-1955), one of the world's ablest explorers, was the first man to reach the North Pole. (As his companion, Admiral Robert Peary, watched, Henson planted the American flag at the Pole in celebration of this historic moment). Many long years of hard work, discouraging setbacks, and painful struggle lay behind this moment of triumph. Henson, who was born in Maryland, had a difficult childhood. His only real education came from the kindly captain of a ship on which he served as a cabin boy for five years. Those years awakened in him a love of travel and a desire for knowledge. Henson eagerly accepted Peary's invitation to accompany him on a trip to survey for a possible canal across Nicaragua. Although he was hired as a servant, his skills and determination soon made Henson a valuable member of the survey team. As a result, when Peary decided to undertake his first voyage of Arctic exploration, he asked Henson to accompany him. This was the first of the seven journeys they made to the Arctic, journeys culminating in that final day of triumph and discovery. In the many years Henson spent traveling and living among the Eskimos, he became one of the world's foremost authorities on the

Arctic. This led to a consultant job with the American Museum of Natural History in New York, two honorary degrees, numerous medals and awards and perhaps most memorable, the heartfelt accolade of Peary, "I can't get along without him." Although outbursts of racial prejudice delayed the presentation of some of these awards, it could not stop this man, who began as Peary's servant and became his partner in one of mankind's most challenging pursuits of adventure and conquest.

ADDITIONAL LISTING OF BLACK SCIENTISTS AND ENGINEERS*

	Name, Place and Date of Birth	Education and Awards	Position and Contributions
1.	Fredreda C. Akers New York	B.S., mathematics North Carolina College	Software Systems Analyst NASA/Goddard Space Flight Center
2.	Rhonda L. Alcorn	B.S., mathematics Texas Southern University	Aerospace Engineer NASA/Johnson Space Center
3.	Percy E. Baynes North Carolina	B.S., M.S., mathematics Howard University	Manager, Shuttle Orbiter Data Processing and Software NASA/Headquarters
4.	Otis Boykin (1920-)		Control unit for artificial heart stimulator, variety of other electronic devices for guided missiles, computers, TV's, etc.
5.	Clarence E. Catoe Washington, D.C.	M.S., theoretical physics Ph.D. candidate	Information Systems Chief Guidance, Control and/Information Systems Division NASA/Headquarters
6.	Shirley A. Chevalier Texas	B.S., electrical Engineering Prairie View A & M University *Who's Who in American Colleges and Universities*	Electrical Engineer NASA/Johnson Space Center
7.	Christine M. Darden North Carolina	B.S., mathematics Hampton Institute M.S., mathematics Virginia State College	Engineer NASA/Langley Research Center
8.	Joyce T. Dooley Virginia	B.A. physics (departmental honors), Hampton Institute *Outstanding Young Women of America* *Who's Who in American Colleges and Universities*	Aerospace research NASA/Lewis Research Center
9.	Julian M. Earls Ph.D. Virginia	B.S., physics Norfolk State College M.S., physics University of Rochester M.A., Environmental Science	Chief Office of Environmental Health NASA/Lewis Research Center

* NASA employees' names taken from *Minority Profiles;* other names from *Black Contributors,* and *I'm Madly in Love With Engineering.*

		University of Michigan Ph.D., radiation physics University of Michigan *Outstanding Young Men in America* *Distinguished Young Black Americans*	
10.	Heibert G. Epps Louisiana	B.S., mathematics (departmental honors) Fisk University	Senior Programmer/Analyst NASA/Johnson Space Center
11.	Diane M. Ford	Mathematics degree Alabama A. & M. University	Mathematician Science and Engineering Data Systems Laboratory NASA/Marshall Space Flight Center
12.	Joseph Fuller, Jr. Texas	B.S., physics and math Texas Southern University; M.B.A., University of Houston	Assistant Executive Officer NASA/Headquarters
13.	Isaac T. Gilliam IV Arkansas	B.S., mathematics Howard University Distinguished Military Student NASA's Distinguished Service Medal	Director Space Shuttle Operations Dryden Flight Research Center/NASA
14.	Yolanda Scott George	B.S., biology Xavier University M.S., biology Atlanta University	Cancer Research Assistant, Lawrence Livermore Laboratory
15.	Meredith Gourdine (1929-)		Means of making high voltage electricity from gas; invented "Incineraid," which reduces the pollution from incinerators
16.	James A. Harris Virginia	B.S., mathematics Virginia State College M.S., mathematics College of William and Mary M.S.A., information technology George Washington University	Math and Data Analyst NASA/Langley Research Center
17.	Gilbert A. Haynes Virginia	B.S., physics Virginia State College	Head, Spacecraft Power Systems Section NASA/Langley Research Center
18.	Billy T. Hervey Texas	Graduate of Prairie View A & M University Presidential Medal of Freedom Award	AST-Technical Management, Engineering and Development Directorate NASA/Johnson Space Center

19.	Earl B. Jackson Maryland	B.A., mathematics and biology Maryland State College	Experiment Manager C-B and Systems NASA/Wallops Flight Center
20.	Mary W. Jackson Virginia	B.S., mathematics and physical science, Hampton Institute *Community Leaders and Noteworthy Americans*	Aerospace Engineer AST-Fluid Mechanics NASA/Langley Research Center
21.	Zella N. Jackson	B.S., mechanical engineering M.B.A., production management Michigan State University	Engineer, Dow Chemical, Western Division, Pittsburg, California
22.	Annglnetta Johnson	B.A., mathematics Texas Women's University *Who's Who in American Colleges and Universities*	Engineer NASA/Johnson Space Center
23.	Peter Jones Virginia	B.S., electrical engineering Howard University	Aerospace Engineer Goddard Space Flight Center/NASA
24.	Robert B. Lee III Virginia	B.S., Norfolk State College M.S., engineering physics University of Virginia	Project Manager Stratospheric Ozone Determination Project NASA/ Langley Research Center
25.	Vance H. Marchbanks M.D.		Head Physician, Project Mercury, Chief of Environmental Health Services with United Aircraft Corporation; inventions include a gas mask tester; a method to measure pilot fatigue; design of space suits and monitoring systems; collection of medical information on astronauts before and after space flights.
26.	Dudley G. McConnell Ph.D.	M.S, and Ph.D., mechanical engineering Case Western University	Assistant Associate Administrator for Applications NASA/Headquarters
27.	Izella Mitchell Alabama	B.S., mathematics Tennessee State University *Who's Who in American Colleges and Universities*	Electrical Engineer NASA/Johnson Space Center
28.	Walter A. Payne, Jr.	B.S., chemistry American University M.S., physical chemistry University of Maryland	Chemist Lab for Extraterrestrial Physics NASA/Goddard Space Flight Center

29.	Lynwood P. Randolph Ph.D. Virginia	B.S., Virginia State College Ph.D., physics Howard University	Program Manager Advanced Electronic Materials and Applied Mathematics NASA/Headquarters
30.	Robert E. Shurney	B.S., physics A & I State University	Man/System Engineer NASA/Marshall Space Flight Center
31.	Earnest C. Smith	M.A., math University of Arkansas NASA's Exceptional Service Medal	Aerospace Engineer NASA/Marshall Space Flight Center
32.	Rufus Stokes (1922-)		Invented an air purification device to reduce the gases in smoke.
33.	John L. Tarplay North Carolina	B.S. (honors), electrical engineering North Carolina A & T State University	Materials Consultant NASA/Goddard Space Flight Center
34.	Robert H. Tooley Florida	B.S., mathematics Florida A & M University	Electronic Engineer NASA/Kennedy Space Center
35.	Sarah Breedlove Walker (Madam C. J. Walker) (1869-1919)		Made cosmetic products for Black women (included straightening comb and a hair softener); was one of first American women to become a millionaire by her own skills.
36.	Ernest Wilkins, Jr. (1923-)	Graduated college at 17, M.S. at 18, Ph.D. from the University of Chicago at 19	One of six Black scientists involved in the development of the first atomic bomb.

OTHER INVENTIONS BY BLACKS*

Name	Invention	Date
Allen, C. W.	Self-leveling table	November, 1898
Ashbourne, A. P.	Process for preparing coconut for domestic use	June, 1875
	Biscuit cutter	November, 1875
	Refining Coconut oil	July, 1870
	Process of treating coconut	August, 1877
Bailey, L. C.	Folding bed	July, 1899
Binga, M. C.	Street sprinkling apparatus	July, 1879
Boone, Sarah	Ironing board	May, 1892
Brooks, C. B.	Street sweeper	May, 1896
Burr, J. A.	Lawn mower	February, 1899
Butts, J. W.	Luggage carrier	November, 1899
Cralle, A. L.	Ice Cream mold	February, 1897
Dorticus, C. J.	Machine for embossing photos	April, 1895
	Photographic print wash	April, 1895
Hawkins, J.	Gridiron	March, 1845
Hunter, J. H.	Portable weighing scales	November, 1896
Jackson, Augustus	Ice Cream	1832
Johnson, D.	Grass receivers for lawnmowers	June, 1890
Johnson, W.	Egg beater	February, 1884
Leslie, F. W.	Envelope seal	September, 1897
Miles, A.	Elevator	October, 1887
Murray, G. W.	Cotton Chopper	June, 1894
Purdy, W.	Folding chair	June, 1889
Purvis, William	Machine for making paper bags	1884

*Selected from *The Negro Almanac*, Third Edition (see Bibliography).

Ray, L. P.	Dust pan	August, 1894
Standard, J.	Oil stove	October, 1889
Sweeting, J. A.	Cigarette roller	November, 1897
White, J. T.	Lemon squeezer	December, 1896
Winters, J. R.	Fire escape ladder	Audust, 1878

BIBLIOGRAPHY

1. Adams, Russell. *Great Negroes Past and Present.* Chicago: Afro-Am Publishing Company, 1964.

2. *Afro-American Encyclopedia.* Editor Martin Rywell. Educational Book Publishers, Inc., North Miami, Florida, 1974.

3. *Afro-America History Series: A People Unrooted 1500-1800.* Edited by Benjamin Quarles, Ph.D. Encyclopedia Britannica Education Corporation, Vol. 1, 1969.

4. Allen, W. W. and D. Murray. *Banneker, The Afro-American Astronomer.* Privately published by the authors, Washington, 1921.

5. *American Black Scientists and Inventors.* National Science Teachers Association, Washington, D.C., 1975.

6. Baker, Henry E. "The Negro in the Field of Invention," *Journal of Negro History.*

7. Bennett, Lerone. *Before the Mayflower.* Baltimore: Penguin Books, 1964

8. Bolton, Sarah. *Lives of Poor Boys Who Became Famous.* New York: Crowell, 1947.

9. Burke, Fred. *Africa.* Boston: Houghton Mifflin Company, 1970.

10. Davidson, Basil. *Discovering Our African Heritage.* Boston: Ginn and Company, 1971

11. Downing, Lewis K. "Contributions of Negro Scientists," *The Crisis,* Vol. 46, No. 6, June, 1939.

12. Drew, C. R. "Negro Scholars in Scientific Research," *Journal of Negro History,* April, 1950.

13. Edison Pioneers. *Tribute to Latimer.* New York, 1938.

14. Edwin, Embre. *Against the Odds.* New York: The Viking Press, 1946.

15. Haber, Louis. *Black Pioneers of Science and Invention.* New York: Harcourt, Brace & World, 1970.

16. Hall, L. A. "The Negro in Chemistry," *School and Society,* Vol. 52, July 6, 1940.

17. Hayden, Robert C. *Seven Black American Scientists.* Reading, MA: Addison Wesley, 1970.

18. Katz, William. *Eyewitness: The Negro in American History.* New York; Putman Publishing Corporation, 1968.

19. Klein, Aaron. *The Hidden Contributors.* New York: Doubleday & Company, Inc., 1971.

20. Kreinberg, Nancy. *I'm Madly in Love With Engineering and Other Comments About Their Work by Women in Science and Engineering.* Berkeley, California: The Lawrence Hall of Science, U. C., 1977.

21. Logan, Rayford and Irving Cohen. *The American Negro: Old World Background and New World Experience.* Boston: Houghton Mifflin Company, 1967.

22. Maché, Dinah L. *Women in Science* (Illustrated Interviews with cassettes and slides). Stony Brook, N. Y.: American Association of Physics Teachers, State University of New York. November, 1975.

23. Meade, G. P. "A Negro Scientist of Slavery Days," *Negro History Bulletin,* Vol. 20, No. 7, April, 1957.

24. Meriweather, Linda. *Black Contributors.* (Draft) Stony Brook, N. Y.: National Coordinating Center for Curriculum Development, 1976.

25. *Minority Profiles.* NASA

26. *Negro Almanac, The.* Editors Harry A. Ploski, Ph.D. and Ernest Kaiser. New York: The Bellwether Company, 1971.

27. *Negro Almanac, The.* Editors Harry A. Ploski, Ph.D. and Warren Marr,II. New York: The Bellwether Company, 1976.

28. Ploski, Harry and Ernest Kaiser. *Afro U.S.A.: A Reference Work on the Black Experience.* New York: Bellwether Publishing Company, 1971.

29. Rich, Evelyn Jones and Wallerstein, Immanuel. *Africa. Tradition and Change.* New York: Random House, Inc., 1972.

30. Sarton, George. *A History of Science.* New York: W. W. Horton Co., 1957.

31. Sterne, Emma G. *Blood Brothers: Four Men of Science.* New York: Knopf, 1959.

32. Stratton, Madeline. *Negroes Who Helped Build America.* New York: Ginn and Company, 1965.

33. Stull, Edith. *Unsung Black Americans and Their Notable Achievements.* New York: Grosset & Dunlap, 1971.

34. Williams, D. H. "Stab Wound of the Heart and Pericardium--Suture of the Pericardium--Recovery Patient Alive Three Years Afterward," *Medical Records of New York,* Vol. 51, March 27, 1897.

35. Wright, C. W. "Negro Pioneers in Chemistry," *School and Society,* Vol. 65, February 1, 1947.

HISPANIC CONTRIBUTIONS TO SCIENCE, MEDICINE, AND TECHNOLOGY

Prepared by

Mary Domb Mikkelson

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PREFACE

Hispanic Contributions to Science, Medicine And Technology, a compilation of historical and biographical data, can be used both to extend and enrich the regular curriculum and to strenghten cultural awareness, appreciation, and pride. Both goals may be met when, for example, a discussion of the nervous system includes mention of the work of Nobel Laureate Ramon Y Cajal or when the contributions of such prominent scientists as Juan Vucetich (fingerprint classification), Dr. Domingo Liotta (heart transplants) or Dr. Luis Alvarez (hydrogen bubble chambers) are described.

Hundreds of men and women are listed, among them some of the world's most prominent physicians and scientists. Classroom recognition of their many and important achievements--an acknowledgement that accomplishment knows no racial or ethnic boundaries--can benefit both Hispanic and non-Hispanic students.

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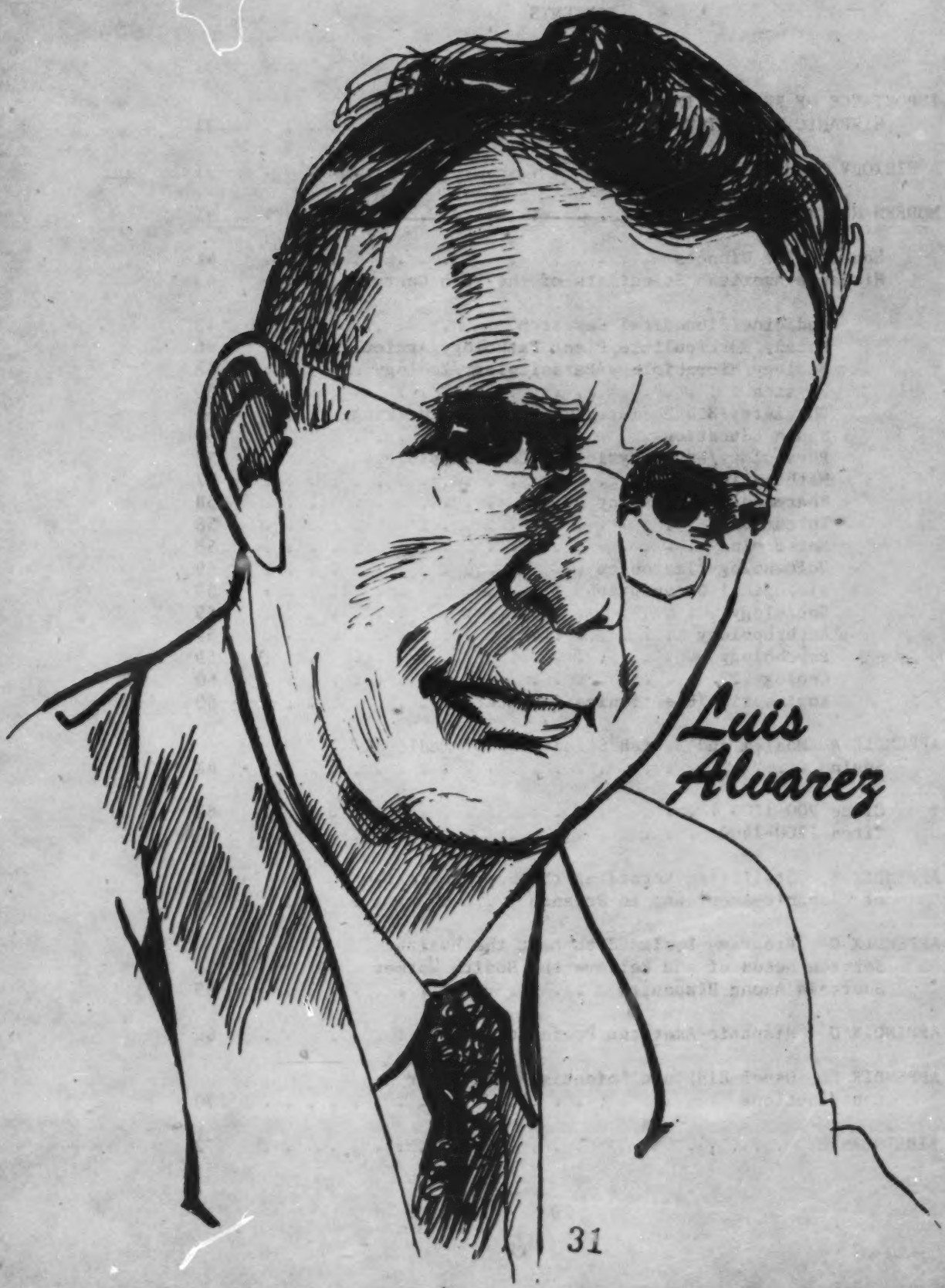
Luis
Alvarez

IMPORTANCE OF RECOGNIZING CONTRIBUTIONS OF HISPANIC* SCIENTISTS

Heroes (examples, role models, those of whom it can be said "If he/she did it, so can I!") are especially important to minority students seeking to change the patterns of the past. Because little has been written--or taught--about the accomplishments of Hispanics, especially those in the fields of science, medicine, and technology, students have not had the opportunity to identify with Hispanic "heroes" in these areas.

Achievement is not--and should never appear to be--the sole province of any one group or culture. When limited vision is allowed to distort this reality, <u>everyone</u> suffers. A knowledge and appreciation of the many and significant contributions made by Hispanic scientists can--and should be--a part of the education of all students.

A HISTORY OF HISPANIC SCIENCE

Hispanic science, which has roots in both Spain and the New World lands of Mexico, Central and South America, has, over the centuries, born the stamp of many different cultures.

The cave dwellers of the Paleolithic Era (the time when humans first learned to handle and shape materials, to use fire, and to study the animals and plants they encountered), showed a talent for biological observation; a trait revealed in such remarkably accurate drawings of animals as the well-preserved paintings of standing and squatting bison at Altamira, Spain. Painted in red and outlined in black, these pictures were the work of a people who took great pains to mix their colors properly. They used soot to make black paint, and iron for the red and yellow colors. Their paints were stored in bones (especially skulls) then mixed with water and applied to the cave walls with fingers and brushes.

In Roman Times, Lucius Cornilius Balbus, a mathematician born in Cadiz (a city founded by the Phoenicians) during the early first century B.C., became Caesar's chief engineer and later, a prominent government official.

From the fourth century until the days of the Moorish invasion, the expansion of the Roman Empire and the spread of Christianity impeded the progress of science. The need to conform to established belief or face a charge of heresy, and the tendency to limit the practice of science to churchmen, combined to make this an era of scientific stagnation.

Isidore of Seville was perhaps the best known Spanish scholar of the early Middle Ages; a time when the study of natural phenomena was considered by many Church authorities to be an affront to God. His often credulous *Etymologiae*, a 20 volume encyclopedia of the arts and sciences which salvaged much of the learning of

*Hispanic refers to a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race or country of birth.

the Greeks, was one of the most influential works of the time. (Strangely, he declared the reading of heathen books a heresy because he believed an increase in learning meant a corresponding increase in the sin of pride.) In an era when the church was just coming to terms with the popular science of astrology, Isidore accepted many of its tenets. He distinguished, however, between natural astrology (in which the moon influenced plant and animal life and controlled the humours of man) and superstitious astrology (which dealt with predictions and prophesies).

Early in the 8th century A.D., the conquering Moors entered Spain, bringing with them knowledge of Arabic, Hindu, and some Greek science. For several centuries Spanish science was to reflect the contributions of three widely divergent cultures--Moslem, Christian and Jewish.

The ninth and 10th centuries saw the creation of a remarkable and distinctive Arabic civilization in Spain and a stage of development unequalled then--or for many centuries later--in Christian Europe. Cordova, the seat of the Moorish government, had at its height for example, some 200,000 homes and miles of paved and lighted streets. The Emirs (rulers) of Cordova became, as had their predecessors in Asia, patrons of learning. Thanks to their influence, Spain became a wealthy, enlightened country. Loving luxury, the Spaniards encouraged the making of rich leathers and fine swords; the raising of Arabian horses; and the development of such new industries as silkweaving, glass and paper making, and enameling. Silver was mined at Jaen; pearls found at Catalonia; and coral taken from along the Andalusian coast. The Persian garden (now reflected in the typical Spanish garden) was introduced, as were the exotic semi-tropical fruits, vegetables, plants, and trees whose growth was made possible by new irrigation techniques.

At first the fatalism inherent in the Moslems' faith inhibited the pursuit of scientific studies unrelated to manufacturing or agricultural procedures. The Spanish Jews' involvement in pure science spurred the Arabs' interest; however, and because contact with the Jews was not as limited as was that with the Christians, they were soon on the way to what has been called the golden age of Moorish science.

That age was indeed a golden time, a period when a single library contained over 600,000 volumes; when 400 camels were required to transport the books of a prominent doctor; and when a wealthy man might donate upwards of 200,000 pieces of gold to found a college (Sedgewick & Tyler). Cordova became the center of scientific investigation with medical knowledge, in particular, being much sought after. It was here, too, that veterinary surgery first became a full-fledged science.

Botany, pharmacy, astronomy, alchemy, metallurgy, horticulture, and aboriculture were among the popular studies of the time. Algebra and other mathematics were put to practical uses. A mariner's compass was invented. The Giralda, the first observatory in Europe, was built in Seville; astronomy then became so popular that rich students were soon building private observatories for their own use.

Because pilgrimages to Mecca were a religious duty for the devout Moslems, travel, with stops at the major cities of the time, became commonplace. On these journeys, scientists visited their colleagues in other areas, copied

manuscripts, and discussed new discoveries. As all spoke the same language, their knowledge soon spread throughout the empire. (From there it travelled to France and Italy, the low countries, Scotland, and England).

The Jews, many of whom spoke the Moors' language, shared in this scientific exchange. Unhampered by the Christian religious restrictions regarding dealings with infidels, they found the whole of Arabic literature available for their use.

Most Christians of this period, in keeping with the teachings of their church, saw the world and its contents as finite and subject to the inevitable destruction awaiting all things mortal, an attitude inconducive to scientific research. Curiosity and heresy were too closely related for comfort and many regarded science as a tool of the oppressors. The sciences of astrology and alchemy were practiced, however. One of the best known Christian astrologers and chemists of the time was Hugh of Santalla who worked under the patronage of Michael, Bishop of Taragona. His writings included the earliest Latin version of an alchemy text, work on geomancy, and two treatises on spatulamancy.

In bringing scientific knowledge to Christian Spain, the Jews again took the lead. Well-educated, with a fluent command of language, they worked in groups of three or more to translate the writings of the Arabs. Arabic was rendered first into the vernacular or Hebrew, then into Latin, then into popular literary form. Many technical terms could not be translated and so the language of the Medieval Latins (and by extension, today's English) was enriched with such astronomical and mathematical terms as azure, zero, zenith, cipher, azimuth, algebra, and nadir. The 10th through 12th centuries were a high period of Jewish learning in Spain and their works, whether original or translated from the Arabic, greatly influenced the directions taken by Western thought. (A list of the great Jewish and Moslem scientists who were residing in Spain circa 900-1200 a.d. and who helped direct the course of Hispanic science is included in Appendix A).

As Moslem control weakened (a trend which could be seen by the end of the 11th century, though Moorish scientists would be a part of Spanish history for years to come) and the Jews became ever more isolated from the mainstream of Hispanic life, Spain and its science grew increasingly western in orientation.

Alfonso X of Castile (1221-1287), while not the most successful of Spanish monarchs, was so noted for his scholarship, encouragement of learning, contributions to law, poetry, and the recording of history and commentaries on alchemy, that he became known as Alfonso el Sabio (the Wise). The revised planetary tables he ordered prepared (based on the Ptolemaic view of the universe and known as the Alfonsine Tables) were the best available for the next three centuries. He is also remembered for commenting during their preparation that had God sought his advice during the days of creation, he would have recommended a simpler design for the universe. Several centuries later a moon crater--"Alphonsus"--was named in his honor.

Arnald of Villanova (1235-1311), an alchemist, was apparently the first person to notice that wood burning in a place where the ventilation was poor gave off toxic fumes. He thus, effectively, discovered carbon monoxide, and was the first to prepare pure alcohol. He was also one of the earliest proponents of the Hippocratic method of observing and recording disease symptoms. A believer in astrological alchemy, he thought the seven planets controlled the seven metals, as they did the organs of the human body.

Peter Gallego (1236-1267), prominent churchman and first bishop of Cartagena (1250-67), translated Aristotelian zoology from an Arabic abridgement.

Alphonso of Cordova, a physician (circa 1340), was one of the first persons to distinguish between ordinary boils and abscesses and those resulting from the plague. He wrote a well-known book on the plague of 1348.

The False Gerber (circa 1300), believed to be a Spaniard, was the first to describe sulfuric acid, the most important chemical used today. That discovery (along with that of other strong acids) was the greatest chemical achievement of medieval times. It made possible chemical changes not changed with vinegar, the strongest acid previously known. (One or two Arabic scholars were also known as "Gerber" and they were also confused with a famous alchemist of that name.) (A list of the famous Moslem and Jewish scientists residing in Spain circa 1200-1400 A.D. is included in Appendix A.)

The Renaissance years (1450-1600) were a time of revolt against the ideas of the Middle Ages, especially those showing the influence of such Arabic scholars as Avicenna and Averroes (see Appendix A). Unlike their Medieval counterparts who often displayed a fear of novelty, the scientists of the Renaissance sought the unusual, the revolutionary. They were, in a sense, dilettantes, studying science for its own sake. As an avocation, science conferred great prestige but in those years (and in most of the century to follow) "working for a living" was regarded as beneath the dignity of the educated aristocrat. Physicians, even eminent ones, were generally poorly paid men of modest social backgrounds, men engaged in a profession tainted by Judaism. Ranked even lower on the social scale were those in the manual trades of surgery and chemistry. There were no outstanding names in physics or pure math, studies frowned upon by the educators of that era. This was a time of exploration and conquest (made to spread the gospel and fill the royal treasuries), and the beginning of the modern Colonial age; a time when the sciences necessary for taking and developing new lands (botany, geography, metallurgy, medicine, map-making and navigation) came into prominence; a time when Spain became the first of the great World powers.

It was also, unfortunately, a time of persecution; the time of the Inquisition and of Calvin; a time when new and foreign books--and ideas--were banned by the Church; when Spanish students were forbidden to attend the Universities of other countries.

The exploits and conquests of the great navigators and explorers, their discoveries of new lands and new wealth, and their harsh treatment of the Indians are well-documented. Less well-known are the scientific and medical discoveries that were a natural outgrowth of the age of exploration.

During his first crossing of the Atlantic, Columbus (a Genoese), with the aid of his Spanish crew, rediscovered declination, the angular difference in direction between true north and magnetic north. His observations (further ones were made when returning from his second voyage) prompted new studies of terrestrial magnetism and in 1525 Felipe Guillen, a Seville pharmacist, built a combination sundial-compass with which to measure declination (the first of many such devices, few of which were truly successful).

Diego Alvarez Chanca, court physician to Ferdinand and Isabella of Spain, was one of those who joined Columbus on his second voyage to the New World. He is

credited with saving the lives of Columbus and several others who were stricken with malaria. The author of a rather remarkable account of the New World that he observed during his three month stay, Chanca also chose the location of the first permanent settlement (Isabella, Haiti) and wrote a study of the treatment of pleurisy. Another physician involved in the care of Columbus' men was Rodrigo Ruiz Díaz De Isla, who treated them for syphilis upon their return. Syphilis and pellegra, which was diagnosed as resulting from a diet centered too heavily on corn,(two diseases previously unknown in Europe) were first seen among Columbus' crew. (Gaspar Casal, (1679-1759), who has been called the Spanish Hippocrates, was the first physician to fully describe pellegra, a condition he called mal de la rosa. To this day, pellegral lesions on the back of the neck are called Casal's collar or necklace.)

Don Martin F. DeEnrico (b. Seville circa 1450, d. 1519), navigator, author of books on geography and founder of the city of Santa-Maria, St. Domingo, is remembered as the man who, at the Isthmus of Panama, first noted the difference in the levels of the Atlantic and Pacific Oceans.

Among the early Spanish visitors to the Americas were botanists, naturalists, and geographers interested in studying the New World.

Nicolas Monardes (b. Seville 1507, d. circa 1578), a botanist, physician and author, recorded some of the earliest botanical and zoological descriptions of the West and East Indies and acclimatized a number of American plants in Seville. (The botanical genus *Monarda* in the Linnaeus' class of Diandria is named for him.)

José De Acosta (1539-1600) spent the years from 1570 to 1588 as a missionary in Peru. Among his books was one describing the plants and animals of Peru and Mexico. Known as the Pliny of the New World, he was the first person to describe the symptoms of Mountain Sickness (Acosta's Disease); the discoverer of a simplified modification of the amalgamation process used in silver mining; and the developer of a system of plant and animal classification. (Bartolme de Medina is credited with first using mercury to extract silver; Juan Capellina with the invention of capellina, which made possible the recovery of the mercury used in Medina's process; and Cristobal Irango, with the invention of a hydraulic pump used in mining.)

Another missionary who traveled in Peru and Mexico, Fray Antonio Vasquez De Espinosa (1570-1630), is remembered for his books on his travels and on the West Indies, and for describing the preparation of mercury from cinnabar.

Gonzalo Fernandez De Oviedo Y Valdés (b. Madrid 1478, d. 1557) was the author of the first natural history of America, the *Historia General Y Natural De Las Indias Occidentales;* a book in which he described a wide variety of mammals, edible and medicinal plants and birds.

Juan Diez Freile, the first mathematician in the Americas, wrote the first book of accounting published there, while Diego Garcia de Palacios wrote the first New World book on naval construction and navigation, and Pedro Paz, the first general arithmetic text.

Pedro Barba (1608-1671), a physician, wrote the first treatise on chicona bark and its uses in the treatment of malaria. (Later, Bernado Antonio Gomes isolated quinine.) Francisco Braco (16th century) wrote the first Spanish language medical book published (1570) in the Americas. It included the first description of

tabardillo (Mexican or Spanish typhus). An earlier work (written in 1500 in Nahuatl, the language of the Aztecs) resulted from the efforts of Martin De La Cruz.

The teaching of medicine came to Mexico in 1525. In 1551, the University of Mexico opened and in 1580, a Chair of Medicine was established. Pedro Lopez, the medical school's first graduate, founded a leper hospital in St. Lazarus. The first doctor in Puerto Rico (one Villalobos) came to that island, then called Boriñken, in 1510. The first New World hospital opened in Santo Domingo in 1503 and, in 1523, a hospital for Indians suffering from diseases introduced by the Spaniards was built.

Alvaro Alonso Barba (1590- ?), a priest and metallurgist, went to South America circa 1609 and settled in Lepas, Peru in 1617. He described the amalgamation process used in the mines of Potorsi; wrote a detailed account of the ores and metals of South America; described the generation of metals; discovered a process for extracting gold; silver, and copper by boiling with a salt solution, and mercury in a copper kettle; and described the extraction of these metals by fusion.

Don Carlos De Sigüenza (b. Mexico City 1645, d. 1700) was one of the first prominent scientists born in the New World. A Jesuit priest and astronomer, he taught mathematics and astronomy at the University of Mexico, wrote books on astronomy and studied the comet of 1680.

Leo Africanus (b. Granada circa 1494, d. circa 1552) was a Spaniard whose explorations took him far from the Americas. He traveled extensively in Africa and on one trip ascended the Nile from Cairo to Assuan. There, he was captured by pirates and sent to Rome where he was converted to Christianity. His *Descrittione dell 'Africa* was for many years the only source of knowledge about the Sudan and, until the 19th century, the primary source of what was known about Islam.

Francisco Diaz (1550-1646), personal physician to Phillip II and teacher of philosophy at the Alcala 'de Henares, traveled in yet another direction--to the Phillipines in 1632 and later, to China. He is best known, however, as the founder of the medical specialty of urology and for his publications on kidney, bladder, and urethral diseases.

Perhaps the best known Spanish physician of Renaissance times was Michael (Miguel) Servetus (Servet, Serveto) (b. Navarre 1511, d. 1553). A tormented man whose religious views were considered heretical by both Catholics and Calvinists, he was, first and foremost, a classical scholar. He injected his scientific ideas into his religious books, some of which were hard to distinguish from his theology. Believing that the blood carried with it the divine spirit, he decided that knowledge of the soul was dependent on knowledge of the flow of blood through the body. His studies led him to discover the lesser or pulmonary circulation of blood and the purification of blood by the lungs. He explained digestion as a source of animal heat and was one of the first people to teach that the venous and arterial systems connected outside the heart. These ideas and discoveries were buried among his religious writings and thus remained, little known, understood, or accepted. The bulk of his writings, particularly his rejection of the trinity and opposition to infant baptism, were all too well-known however, and led to his condemnation by both the In-

quisition and Calvin. He escaped the clutches of the former only to be captured and burned at the stake on the order of the latter.

Other notable Spanish scientists of this period were:

Andrés De Laguna (b. 1499, d. ?), anatomist and personal physician to Charles V; he gave the first description of the ileo-cecal valvule.

Juan Almenar (flourished 1490), author of one of the earliest extant descriptions of syphilis and advocate of the mercury treatment for this disease.

Juan Bautista Herrara (1530-1597), a noted mathematician, architect, and translator who founded the Madrid Academy of Mathematics, verified maps of India and America, furthered the knowledge of Arabic math in Spain, and was in charge of the construction of the Escurial Palace and the bridge at Segovia.

Juan Andrés (flourished 15th century), was the author of a math book and a noteworthy description of finger symbolism.

Luis Vives (1492-1540), was a famous advocate of advanced educational theories (including active participation by students in the learning process, physical training and activity, and education for women), international peace and curing poverty, and wrote the first modern treatise on psychology.

Juan Pablo Bonet (b. Aragon 1575, d. circa 1630), a physician who devised a method of teaching the deaf and mute to speak and communicate with finger spelling and who authored an alphabet for their use.

Francisco Solano De Lucques (1685-1736), physician and author who was the first western doctor to insist on the use of the pulse in prognosis and who described three types of pulse.

José Quer Y Martinez (1695-1764), a botanist and physician who traveled extensively throughout Spain, Italy, and Africa and made studies of the plants native to those countries. The founder of Madrid's Botanical Garden and head of several scientific expeditions, he authored one of the first published works on Spanish plants.

The Indians of the New World--the Incas, Aztecs, and Mayans--were also notable for their scientific achievements.

The Inca empire of Peru resulted from the union of many previously independent tribes. Political maneuvering and frequently, force, were used by the Incas to organize these tribes into a nation in which land management (terracing of mountainsides and digging of canals for irrigation) and food production resulted from joint effort. Although no new techniques were introduced, a surplus of food resulted and hunger was unknown. The rulers, kept in luxury by the labors of their people, then had the time and inclination to indulge in intellectual pursuits.

Architecture, metalwork (used for ornamentation, not tools), astronomy (a study which led to accurate calendars and the belief that the sun, moon, and stars were divine), math (including the use of knotted quipas or strings for record keeping) and the techniques of warfare were among their scientific accomplish-

ments. Medical techniques included the use of cocaine as an anesthetic, especially when amputations were performed. This was done as early as the first millennium B.C., some 2500 years before the Europeans learned of the practice and nearly 2900 years before they adopted it.

Inca Rocca, the fifth or sixth king of this remarkably advanced nation, was perhaps the most notable of these rulers. An ambitious leader, whose plans for territorial expansion included the conquest of neighboring tribes, he faced and soon solved the problem of how to send his warriors over steep mountain slopes and dangerously torrential rivers. His solution was to design the swinging bridges for which he and his nation became famous. Woven of osiers or willow strands braided together in 3's, then 9's, then 27's, with sides and railings fastened from high spot to high spot across the ravines and gorges, these bridges were wide enough to allow two or three men to walk side by side and so impressive that many of the tribespeople he planned to conquer came voluntarily under his rule. (Today the highest railway in the world--high point, 4830.5 meters--can be found in these mountains. Designed by Henry Deiggs, this line was completed nearly 100 years ago.)

The Aztecs of Mexico were also noted for their scientific and medical knowledge, as were the Mayans. Among the Aztecs, the use of anesthesia was known and the medicinal properties of various herbs classified. Sarsaparilla was used as a diuretic in the treatment of kidney ailments and rubber as plasters for rheumatism and pleurisy victims. Ceramic figures dating back to the first millennium B.C. indicate the use of Caesarean delivery techniques.

Hieroglyphic and pictographic recordings of current events were made by painting on both sides of long strips (approximately 6" wide and up to 34' long) of amatl paper (made from the maguey cactus) or hide, coated thinly with lime. These same people also developed the mathematical concept of zero.

Though unfamiliar with the wheel, the Aztecs built great temples and pyramids and, on an island in Lake Texcoco which had been enlarged by a system of drainage canals, the fabulous lake city of Tenochtitlán was built. Protected from invaders by the use of draw bridges, some 300,000 people lived there and boats were used for house-to-house travel. (Recent archeological findings have revealed that some 500 years ago another Indian tribe, presumably the Mollo descendents of the Tiahuanaco people of Brazil, based their architecture on the trapezoid. There is speculation that the use of this most unusual shape may have been the result of a rare geometric conception.)

These people, who made decorative use of gold, silver, and precious jewels, are best known for the accuracy of their astronomical observations and their carving of the sunstone (calendar stone), which recorded the cyclic movements of celestial bodies and made possible the prediction of eclipses and other events. Among its markings, based on a 365 day year, were ones showing the 18-year eclipse cycle of the moon, the number of days in the synodic "years" of Mars and Venus and the 19 year period in which the phases of the moon will occur on the same days of the year. (A second calendar, the "tzolkin", was used for religious purposes and was based on numerical rather than astronomical calculations.)

The Mayan's calendar was even more accurate than that of the Aztecs. Five hundred years before the Romans devised the same solution, the Mayans added an extra day every four years and thus created a leap year. Their system of num-

bers was one of the most remarkable ever invented; with only three figures--a dot, a stroke, and an oval--they could write numbers of any size. At their Caracol (observatory) at Chichen Itza (in Mexico), alignments made along passages cut in the walls allowed observers to plot the position of heavenly bodies against the passage's edge.

Their pyramids, built over 1000 years before the birth of Christ, reveal the amazing extent of their engineering skills. These advanced civilizations--so reminiscent of the early Egyptians that some researchers believe they must once have been in contact--are an important part of the history of Hispanic culture--and science.

From 1700 to 1900, Hispanic science in both the old and new worlds made great strides. Among the best known scientists of Spain during those years were:

Pedro Virgili (1699-1776), a surgeon and anatomist, founded the Navy Surgical Colleges at Cadiz and Barcelona and is remembered for performing a tracheotomy on a patient suffering from quinsy.

Antonio De Gimbernat (1734-1816), a surgeon and anatomist, originated the spinal method for operating for crural hernia and, in 1768, demonstrated the Lacunar Ligament (still known as Gimbernat's Ligament).

Antonio José Cavanilles (1745-1804), the botanist who became the director of the Royal Botanical Gardens at Madrid and, under the commission of the king, studied the plants and natural history of Spain; wrote many books; described numerous new plants; and was a proponent of the Linnaean system of botany.

Mariano Lagascar (1776-1839), a botanist and author, directed the Botanical Gardens of Madrid; taught at the University of Madrid; made (in 1803) an expedition to classify Spanish flora; and discovered a species of cudbear lichen used to prepare litmus paper.

Augustín De Betancourt Y Molina (b. ? , d. 1824), Spanish engineer and inventor in the service of Russia, founded that country's engineer corps and a high school for exact science; studied the elasticity of saturated water vapor; was the first to experiment with the elasticity of other vapors (i.e. alcohol vapor); calculated the steam pressure curve of water from 0°-135° C. (with Bieguet); invented a telegraph; and built an earth windlass (capstan) whose cable was wound several times around two drums equipped with screw-shaped round timbers.

Manuel Garcia (1805-1906), a music educator (was Jenny Lind's teacher) and inventor who, in researching the physiology of the voice, invented the laryngoscope to examine the larynxes of his pupils and thus laid the foundation for the modern medical study of the larynx.

Jaime Ferran Y Clua (1849-1929), founder of the Bacteriology Institute of Barcelona and student of cholera and immunization, achieved fame by immunizing against cholera in man (some 50,000 in Valencia, 1881-85) and advocating similar treatment for other diseases,

Carlos Ibanez de Ibero (1825-1891), Barcelona geodesist who directed the Geographic and Statistic Institute of Europe, served as president of the International Commission on Weights and Measures from 1872 to 1891, and recognized the geodetic junction of North Africa to Europe.

Spanish scientists known for their work in the New World during this era include:

Antonio De Ulloa (1716-1795), was a member of the French Academy of Sciences' expedition to Peru to measure the degree of meridian at the equator and founded an observatory at Cadiz.

José Celestino Mutis (1731-1808), botanist sent to New Granada (Colombia) in 1760 who collected and studied plants and was the first to distinguish among various species of cinchona.

Félix De Azara (1746-1811), a naturalist and military engineer who, sent to settle a Spanish-Portugese border dispute in South America in 1781, remained for 20 years; collected geographical data; wrote a study of the natural history of Paraguay; and became probably the first and most thorough of South American naturalists and students of animal life.

Don Fausto d'Elhuyar (1755-1833), a mineralogist who, after analyzing (with his older brother) the mineral Wolframite (found in a tin mine) and succeeded in isolating from it the new metal, Wolfram (tungsten), was made director of the mines of Mexico.

Andrès Manuel Del Rio (1764-1849), a mineralogist who, in 1794, was sent to Mexico City to be a professor at the School of Mines established by Elhuyar and, in 1801, discovered a new metal, erythronium (vanadium), in lead ore. Convinced by other scientists that it was really chromium, he gave up his claim to the discovery. (It was later rediscovered by Sefström).

A number of New World scientists came into prominence during these years. Included among them were:

Juan Ignacio Molina (b. Guaracalen, Chile 1740, d. ?), a naturalist and priest, founded a library at Talca, Chile; studied the natural resources of Chile; wrote historical, geographical, and botanical work; and for whom were named several genera of plants and a town in Chile.

Jose Antonio Alzate Y Ramiriz (1738-1799), Mexican astronomer, geographer, and priest directed scientific missions for both the government and the Roman Catholic church; founded the *Diario Literario* (newspaper) in 1768; made extensive maps of Mexico; and wrote on such subjects as astronomy, physics, metallurgy, silk growing, and the use of ammonia against gases in mines.

Francisco Antonio Zea (1770-1822), Colombian naturalist and politician, made scientific explorations with José Murtis; became a professor of natural science and director of the Royal Botanical Garden in Madrid; returned to South America in 1814, and fought there with Bolivar against Spain; served as vice president of Gran Colombia and minister to England; and authored scientific treatises and a history of Colombia.

Josè Hipolito Unanue (1758-1833), Chile-born scientist and leader, helped found the anatomy teaching amphitheater at Lima, Peru; advocated the use of vaccination; worked for cleaner streets, better schools, and improved irrigation and mining methods; wrote the famous *The Climate of Lima*; founded the San Fernando School of Medicine; and, after becoming involved in the political upheaval of Peru, emerged as one of its greatest leaders.

Juan Vucetich, Argentine creator of a fingerprint classification system containing a million possible basic subgroups; is credited with setting up the first police fingerprint identification department in La Plata in 1891 and with making possible the first known use of fingerprint identification at the scene of a crime in 1892. (His system is still used--alone or in combination with others--in many countries of the world).

Juan Guiteras (1852-1925), Cuban physician who served as a yellow fever expert in the epidemics starting in 1881, became director of Public Health in Cuba, and a member of the Yellow Fever Commission of the International Health Board (Rockefeller Foundation); discovered filario Bancrofti in the U. S. and uncinaria in Cuba and verified the cause of Yellow Fever independently of Major Walter Reed's army board in 1901.

Benigno Septien Y Bustamente, invented a surveyor's level; Silvestre Diaz de la Vega, the father of the modern rubber industry; Francisco Estrada, invented an electric dynamo motor; Dr. Luis Jose Montana, known for his methods of medical investigation and observation; and Dr. Artur Hanna, who founded the French Hospital in New York in 1800.

MODERN HISPANIC SCIENTISTS

Nobel Prize Winners

Five men of Hispanic heritage have won the Nobel Prize for their contributions to science and medicine, three in the category of medicine and physiology, one in chemistry, and one in physics.

The earliest of these was Santiago Ramón Y Cajal (1852-1934) who received the Nobel Prize in Medicine and Physiology in 1906 for his efforts (using his improved methods of cellular staining) in working out the connections of the cells in the grey matter of the brain and spinal cord (demonstrating the system's complexities); in determining the structure of the eye's retina, and establishing the neuron theory which stated that the nervous system was made entirely of nerve cells and their processes. Born in Petilla, a village in the Pyrenees, Cajal (the son of a "surgeon of the second class"), Cajal was considered backwards while in school, and was apprenticed first to a barber, then to a shoemaker. Thanks to his father's tutoring, he was finally able to study medicine, graduating from the University of Zaragoza in 1873 and taking his medical degree from the University of Madrid. After his compulsory Army service in Cuba, he became a demonstrator and professor of anatomy at Zaragoza; held the Chair of Anatomy at Valencia (where he did research in bacteriology and serology); then, turning to his major field, histology, held the Chair in that subject at Barcelona. In addition to his work which lead to the Nobel Prize, he authored numerous, highly-acclaimed articles and books on the nervous system, and a number of popular essays, including a treatise on color photography.

Argentina-born physician and physiologist, Bernado Alberto Houssay (1887-), the first Latin-American Nobel Prize winner, received that honor in the category

of Medicine and Physiology in 1947. His award-winning research led to discoveries of the crucial functions of the pituitary gland in the body, especially its effect on the course of sugar metabolism (demonstrating that a hormone secreted by the pituitary prevented the metabolism of sugar and that injections of pituitary extract induced symptoms of diabetes) and enabled him to demonstrate the complex interlocking hormonal effects involved. The Juan Peron-controlled press of Argentina considered the Nobel Prize a political affront to Peron; Peron had removed Houssay from his University post because of his anti-Nazi, pro-American opinions. (Houssay's response was that "one must not confuse little things--Peron--with big ones--the Nobel Prize".) Houssay, who worked privately until Peron's exile in 1955, was then reinstated at the University of Buenos Aires Medical School. He is also known for his studies in the physiology of circulation, digestion, and the nervous system, and for research in snake and spider toxins.

Severo Ochoa (1905-), a Spanish-American biochemist, received the Nobel Prize in Medicine and Physiology in 1959. A graduate of the University of Màlaga, he received his medical degree with honors from the University of Madrid; ten doctor of science degrees from schools in the United States, England, Spain, and Israel; a law degree from the University of Glasgow; a doctorate of medical science from the University of Santo Tomas in Puerto Rico; and a Dr. Honoris Causa from the University of Brazil. After leaving Spain in 1936, he spent one year in Germany and three in England before coming to the U. S. in 1940 (he became a citizen in 1956) and becoming (in 1942) a member of the faculty of the New York University College of Medicine. Known for his research on the chemical mechanisms of the body (especially how molecules of carbon dioxide are incorporated into and liberated from compounds), his work (along with that of Lepmann) helped identify the two-carbon fragment, a key compound in the metabolic pattern. He is best known for his work on nucleic acid, and for isolating an enzyme (from a strain of bacteria) which reacts with nucleotides when a second phosphate unit has been added and which, when strung together, form molecules of RNA. With synthetic RNA, unlike the natural RNA in which all varieties of nucleotides exist, he could start with one variety and build up one which was endlessly repeated.

Luis Walter Alvarez (1911-), of the Lawrence Radiation Laboratory in Berkeley, California, was awarded the Nobel Prize in Physics in 1968. Dr. Alvarez, who is also a professor of physics at the University of California at Berkeley, is known for his investigations of the properties of nuclei and of particle resonant states. The co-discoverer of the cosmic ray East-West effect, he also designed the first neutron time-of-flight spectrometer; the first proton linear accelerator; the first charge exchange (tandem) accelerator; several hydrogen bubble chambers and bubble chamber film measuring systems; and was the first to measure the neutron magnetic moment. A patentee in radar and optics and member of the President's Science Advisory Committee, his list of honors and awards includes the Collier Trophy, the Medal for Merit, the Scott Medal, California Scientist of the Year, the Einstein Medal, the Pioneer Award of the Institute for Electrical and Electronic Engineers, the National Medal for Science, the A. A. Michelson Award, and several honorary degrees.

Luis Federico LeLoir (1906-), an Argentine biochemical researcher, received the Nobel Prize in Chemistry in 1970. His major research accomplishments include isolating glucose diphosphate, uridine diphosphate glucose, uridine diphosphate acetylglucosamine, the mechanism of glycogen, starch biosynthesis,

and adenosine nucleotides (from corn grains). Educated at the University of Buenos Aires, he spent several years as a research worker in the United Kingdom and the United States before becoming the director of the Institute of Biochemical Research, Camponar in 1947, and head of the department of biochemistry at the University of Buenos Aires in 1962. The author of books on human physiology and renal hypertension, he holds a number of honorary degrees and has received awards from the Argentine Science Society, the Helen Hay Whitney Foundation, the Severo Vaccaro Foundation (Argentina), and the Bunge and Born Foundation (Argentina).

Hispanic-American Scientists of the 20th Century

Hispanic-Americans are a small but vital part of nearly every field of modern science. Their numbers are sadly limited but their contributions are both extensive and exciting. Although college and university enrollment figures indicate little change in the disproportionate representation of Hispanic students in the sciences (see Appendix B for statistics on the still limited representation of Hispanic-Americans in science), it is hoped that changing attitudes, increased knowledge, and the growing number of new approaches and programs being used to encourage their participation will soon bring about a change in this situation. (See Appendix C for a list of some of the steps being taken to involve Hispanics in medicine.)

On the following pages are listed some of the Hispanic-Americans who have been or are involved in the fields of science, medicine, and technology in the 20th century. (Appendix D contains a partial listing of Hispanic professors in American colleges and universities.)

Medicine/Biomedical Research

Dr. Walter Clement Alvarez (1884- ?), famous American physician, author, and syndicated medical columnist, established the normal standards for human blood pressure and gastric juices; introduced the idea of gradients in the intestinal wall; and made the first electro-gastrograms of humans. Known for his research on psychosomatic medicine, neuroses, migraine, little strokes, and sensory epilepsy, he is the author of a number of books (including *Live at Peace With Your Nerves, Practical Leads to Puzzling Diagnoses, Minds That Came Back* and *Incurable Physician: An Autobiography*; articles and booklets; and was formerly editor-in-chief of *Modern Medicine*. Born in San Francisco, he received his M.D. from Cooper Medical College (Stanford) in 1905, and held a variety of medical and educational positions before becoming a senior consultant and professor of medicine at the Mayo Foundation of the University of Minnesota. He was also the first Caldwell lecturer for the American Roentgen Ray Society.

Dr. Silvio Baez (1915-), associate professor of physiology at Albert Einstein College of Medicine in New York City and director of their Anesthesia Research Lab (current positions listed in this booklet are the most recent mentioned in the reference books), is the inventor of a method for controlled subcooling of cells under microscopic observation, and a method for the measurement and electrographic recording of microscopic objects. A native of Paraguay and graduate of Asuncion Medical School, he has done research in the mechanisms concerning the behavior of small living blood vessels, the reaction of minute vessels in germ free animals, laser irradiation, and hypertension and shock.

Dr. Cesar Augusto Caceres (1927-), physician, author, and developer of automatic flouresecent antibody screening devices for streptococci, is known for his investigations into the feasibility of using ultrasound to detect heart disease and for his research in, and publications on, the formulation and demonstration of automated medical data and signal processing, multidimensional statistics, and analysis of acoustic properties of heart sounds and stethoscopes. The recipient of Superior Service Awards for his work with the Department of Health, Education, and Welfare, he is the author of (with O. Schmidt) *Computer Assisted Studies of Biomedical Problems, Biomedical Telemetry*, and (with L. W. Perry), *Innocent Murmurs*. Born in Honduras, he earned his M.D. at Georgetown University.

Dr. Russell Ramon DeAlvarez (1909-), professor of obstetrics and gynecology at Temple University School of Medicine in Philadelphia, and Obstetrician and Gynecologist-in-Chief at their Health Center, has served as a member on the sub-committee on chemotherapy for gynecological cancer of the National Cancer Institute (Ovarian Malignancy Section); as editor of the *Quarterly Review of Surgery, Obstetrics and Gynecology*; on the editorial board of the *Western Journal of Surgery, Obstetrics and Gynecology*; and the editorial committee of the *American Journal of Obstetrics and Gynecology*. Dr. DeAlvarez, who is known for his research on cancer in women, and lipid and water metabolism, was born in New York City and received his M.D. from the University of Michigan.

Dr. Juan Angel Del Regato (1909-), physician and therapeutic radiologist, director of the Penrose Cancer Hospital in Colorado Springs and professor of clinical radiology at the University of Colorado (Colorado Springs), is known as the designer of a lighting device used for localizing and outlining fields in clinical radiotherapy. He is the author of numerous works on cancer, recipient of many awards, past vice-president and gold medalist of the Radiological Society of North America, and consultant to government agencies and hospitals. Dr. Del Regato was born in Cuba, received his Diploma D.Med. from the University of Paris, and became a U. S. citizen in 1941.

Dr. Hector Garcia (1914-), physician, civic leader, and diplomat, was the founder (and is the present Chairman of the Board) of the American G. I. Forum, a group dedicated to helping Mexican-American veterans upon their return to civilian life. Among his diplomatic positions have been those of alternate delegate to the United Nations, member of the United States Commission for UNESCO, and Commissioner of the United States Committee on Civil Rights. A native of Mexico, he took his M.D. at the University of Texas and was a major in the Army Medical Corps in World War II (receiving the Bronze Star with six battle stars).

Dr. Domingo Liotta (1924-) pioneered in the development and implantation of the first artificial heart in a human and the first paracorporeal circulatory pump, and was project associate director of the Artificial Heart Program at Baylor University. The recipient of many awards, among them the Young Investigator's Award from the American Society of Cardiology, he is also the author of such works as *Early Radiological Diagnosis of Tumors of the Pancreas, Mechanical Devices to Assist the Faulty Heart* and *Heart Substitutes*. Born in Argentina, he took his M.D. and D.M.S. at the National University of Cordoba.

Dr. Josep Garcia Llaurado (1927-), a professor and biomedical researcher at Marquette University in Milwaukee, is known for his investigations into aldo-

sterone and its role in metabolic alterations after surgery; the prolongation of skin transplants by use of synthetic adrenocortical hormones; for demonstrating the anti-inflammatory effects of new steroids; the effects of amphetamine on sodium and potassium excretion; the connective tissue in arteries; and the computer compartmental analysis of sodium distribution in tissues. The author of numerous publications on the construction of the first flame photometer in Spain, Dr. Llaurado (who was born in Barcelona), took his M.D. cum laude from the University of Barcelona and his M.S. in biomedical engineering from Drexel Institute; he came to the U. S. in 1957, and became a citizen in 1966.

Dr. Rafael Rodriquez-Molina (1901-), physician specializing in tropical medicine and a lecturer in clinical parasitology at the University of Puerto Rico School of Medicine in San Juan, has done extensive work in various aspects of hookworm disease, trichiniasis, ascaris infestation, sprue and especially, schistosomiasis. The recipient of a Bronze Plaque for his services to the Pan American Medical Association and one for his work in combating schistosomiasis, he is also the author of a book entitled *Americanization of Manuel de Rosas*. Born in Puerto Rico, he received his M.D. at the Medical College of Virginia and his D.M.S. at Colombia University.

Dr. Juan Manuel Taveras (1919-), professor of radiology and Director of the Mallinckrodt Institute of Radiology at Washington University School of Medicine in St. Louis, and Radiologist-in-Chief at Barnes and Allied Hospitals, is known for his research in radiologic diagnosis of certain diseases of the central nervous system. A past president of the American Society of Neuroradiology, he authored (with Ross Golden) *Roentgenology of the Abdomen*, (with Ernest Wood) *Diagnostic Neuroradiology*, and a number of articles. Born in the Dominican Republic, he took his M.D. at the University of Pennsylvania in 1949, and became an American citizen in 1950.

Other prominent Hispanic-American doctors include:

Name, Place and Date of Birth Education and Awards	Position	Research, Publications, Contributions
1. Dr. Elias Amador (1932-) Mexico M.D., Escuela Nacional de Medicine, Universidad Nacional Autonoma de Mexico	Professor of pathology and chemistry, Charles R. Drew Post Graduate Medical School and U.S.C.; Chief pathologist, Martin Luther King, Jr. General Hospital	Development of accurate and sensitive methods (reproducible enzymatic assays) for the diagnosis and early detection of disease
2. Dr. Guillermo Arbano (1910-) Puerto Rico M.D., St. Louis University; M.P.H., John Hopkins; Bronfman Award of the American Public Health Association	Public health administrator, Puerto Rico Professor of preventative medicine and public health, University of Puerto Rico	Member, International Health Commission Research in typhus fever, shigellosis, Public Health Administration, Health Care and Health Planning

3.	Dr. Agustin Arbula (1928-) Peru M.D., San Marcos University, Lima Frederick A. Collier Award from the American College of Surgeons; Cecile Lehman Mayer Research Award from the American College of Chest Physicians; Regents Award	Thoracic surgeon, Detroit, Mich.	
4.	Dr. Wadi Antonio Bardawil (1921-) M.D., National University of Mexico	Founder, Department of Pathology and Medical Research, St. Margeret's Hospital, Boston; Professor of OB/Gyn. (pathology), Tufts University School of Medicine	Research in vascular diseases, autoimmune diseases, and the pathology of pregnancy
5.	Dr. Carlos Enriquez (1945-) Mexico M.D., Boston University	Children's Hospital, Philadelphia	Pediatrics/subcellular growth
6.	Dr. Jacinto J. Vasquez (1923-) Cuba M.D., University of Havana; M.S., Ohio State University	Professor of pathology, Duke University; consultant, Oak Ridge National Laboratory; member, Editorial Board, *American Journal of Pathology*	Research in pathogenesis of immunologic diseases, immunopathology cellular aspects of antibody formation, cytokinetics of immune respons
7.	Dr. Jorge J. Yunis (1933-) Colombia M.D., Central University in Madrid, Spain	Teacher, laboratory medicine at University of Minnesota Medical School director of their medical genetics lab and of the training program and postgraduate education in clinical pathology	Research in human chromosome methodology, biochemical methodology in red cell genetics; cytogenetics; biochemistry

Botany/Horticulture/Plant Pathology/Agriculture

Prominent Hispanic-Americans in these fields include:

Name, Place and Date of Birth Education and Awards	Position	Research, Publications, Contributions
1. Dr. Jose Manuel Amador (1938-)	Area plant pathologist, Extension Service, Texas A. & M. University	Research in the physiology of diseased plants; sugar cane breeding; identifica-

	Cuba B.S., M.S., Ph.D (plant pathology), Louisiana State University		tion and control of diseases of field crops, citrus, vegetables and ornamentals; evaluation of fungicides
2.	Dr. Jose Antonio Bernabe (1902-) Ph.D., Cornell University	Director, Central Igualdad Sugar Co., Mayaguez; professor of agronomy, College of Agriculture, University of Puerto Rico; sugar cane consultant, Agency for International Development, Ivory Coast	Research and articles on tobacco diseases; disease resistance; inheritance of color in eggplants; inherited resistance to tobacco mosaic virus
3.	Dr. José Cuatrecasas (1927-) Spain Guggenheim Fellow, 1951-52	Research Associate, Department of Botany, Smithsonian; science director, Flora Neotropica; investigator, National Science Foundation	Contributed to knowledge of flora and plant ecology of Spain and tropical America, especially Colombia (through exploration and collections; taxonomic studies; advance of systematic biology in field of phanerogams through monography of several groups
4.	Dr. Teme Paul Hernandez (1919-) Louisiana Ph.D., University of Wisconsin	Professor of Horticulture, Louisiana State University, Baton Rouge	Co-developer of several varieties of vegetables, sweet potato, and tomato
5.	Dr. Alix Vinicio Paez (1936-) Ecuador Ph.D. (crop science), University of Missouri	Plant breeder, Pioneer Hi-Bred International, Inc.	Research in genetics, cytogenetics, physiology, and breeding of corn; research and development in corn endosperm breeding
6.	Alfonso T. Suro-Pico (1910-) Puerto Rico B.S. (agriculture), University of Puerto Rico	U. S. Patent Office	Photographic chemistry
7.	Dr. Ismael Velez (1908-) Puerto Rico Ph.D.,Louisiana State University; Fullbright lecturer in plant pathology in Peru and Ceylon	Head, biology department International American University , San German, Puerto Rico	Research in tropical plants, and methods and programs for teaching biology

Biology/Microbiology/Parasitology/Zoology

A number of Hispanic-American scientists have become known for their work in these fields. Among them are:

Dr. Vernon L. Avila (1941-) of Segundo, Colorado, is an assistant professor of zoology at San Diego State University. Educated at the University of New Mexico (B.S.), Northern Arizona University (M.A.), and the University of Colorado (Ph.D.), he has a special interest in developing teaching programs for educationally disadvantaged minority students and in working with and encouraging these young people to consider scientific careers. (His work along these lines has been the subject of magazine articles, radio and TV programs, and papers presented to organizations interested in the educational problems of minorities). Involved in research in comparative reproductive physiology; the hormonal aspects of behavior; the effect of gonadal androgens on various components of agonistic and reproductive behavior in teleosts; comparative endocrinology of lower vertebrates; and the electron microscopy of procaryotic cells, Dr. Avila has written many articles and research papers, served as a consultant and book and manuscript reviewer for several companies, and as a site consultant for the N.I.H. Minority Biomedical Support Program.

Name, Place and Date of Birth Education and Awards	Position	Research, Publications, Contributions
1. Dr. Carlos G. Aguayo (1899-) Cuba Sc.D. (zoology), University of Havana	Professor of biology, University of Puerto Rico	Research in Antillean Mollusks, systematic malacology, zoogeography
2. Dr. Ronald Herbert Alvarado (1933-) Ph.D. (zoological physiology), Washington State University	Professor of zoology and chairman of department, Arizona State University	Research in osmotic and ionic regulation in amphibians and mechanisms of ion transport
3. Dr. Jose Oliver Gonzales (1912-) Puerto Rico Ph.D., University of Chicago; Howard T. Rickett Prize; Bailey K. Ashford Award; Purdue Frederick Award	Professor of parasitology, University of Puerto Rico School of Medicine	Developed tests for serological diagnosis of Bilharziasis; contributed to knowledge of antigenecity of parasitic forms
4. Elaine F. Munoz California B.A. biology, College of Notre Dame, Belmont, California	Microbiologist, Ames Research Center	Investigation into using changes in electrical impedance in monitoring microbial activity in the waste water treatment process

5.	Dr. John Joaquin Munoz (1918-) Guatemala Ph.D. (bacteriology), University of Wisconsin	Research microbiologist, N.I.H.,National Allergy and Infectious Diseases, Rocky Mountain Lab, Hamilton, Montana	Research in anaphylaxis detection; mixtures of antigens and antibodies; and the mechanisms of hypersensitivity
6.	Dr. Castor Ordonez (1880-1938) Spain Ph.D., St. Mary's Seminary, Perryville, Missouri; Sc.D, Depaul University	Biologist and author	Research in rat cancer; the crossbreeding of turkeys and chickens; made discoveries in uses of electricity; wrote lab manuals and books on biology, genetics, eugenics, and calculus
7.	Dr. Americo Pomales-Lebron (1904-) Puerto Rico Ph.D., University of Michigan; twice a Guggenheim Fellow	Head, microbiology department, University of Puerto Rico	Research in the pathogenesis of brucellus, streptococcal infections, host-parasite relationship at the cellular level; wrote (with others) *Tissue Culture in the Study of Infectious Disease* and many articles
8.	Dr. Agustin Prieto (1926-) Spain Ph.D. (microbiology), Rutgers University	Calbiochem, La Jolla, California	Research in microbial biochemistry
9.	Dr. Juan Arturo Rivero (1923-) Puerto Rico Ph.D. (biology), Harvard	Museum of Comparative Zoology, Harvard	Research in taxonomy, ecology, geography, and the behavior of amphibia
10.	Dr. Franklin Sogandares Panama Ph.D., University of Nebraska	Professor of biology and coordinator for Science Planning, Tulane University; Advisory Panel for Systematic Biology, N.S.F.; Board of Science Advisors, Salt Water Fisheries, Florida State Board of Conservation; Editorial Board *American Midland Naturalist*	Research in host-parasite relationship with special interest in evolutionary biology of parasitism as reflected by digenetic trematodes
11.	Dr. Ralph Trujillo (1940-) New Mexico Ph.D. (biology), Indiana University	Sandia Labs, Albuquerque, New Mexico	Research in biological systems energetics

Physics

Included on the list of prominent Hispanic-American physicists are:

Mel Calderon of the Naval Ocean Systems Center in San Diego, California. Born in New Mexico, he holds a B.S. in physics from New Mexico State University and plans to work toward a Ph.D. in information science at U.C.S.D.

Dr. Manuel A. Gonzales, a research physicist at Naval Ocean Systems Center (NOSC), conducts research in underwater acoustics, structural and fluid dynamics, array theory, signal processing, and numerical analysis as it applies to the solution of acoustical problems. He is also a member of NOSC's Equal Employment Opportunity Committee and, as such, works to recruit minorities and women. A native of Cuba, Dr. Gonzales received his B.S. in electrical engineering from Auburn University; a M.S. in physics, a M.S. in electrical engineering, and a Ph.D. in physics from the University of Washington. An avid rock and mountain climber (including a number of first ascents in the Coast Ranges and Rocky Mountains), he lists photography, cross-country skiing, long distance running, chess, and reading among his other pursuits.

Name, Place and Date of Birth, Education and Awards	Position	Research, Publications, Contributions
1. Dr. Virgilio Acosta (1916-) Cuba D.Sc., University of Havana	Associate professor U.S. Naval Academy	Inventor of equipment for electrolysis and recombination of hydrogen and oxygen
2. Dr. Ernest Charles Alcarez (1935-) Coronado, California B.A., M.S., San Diego State University; Ph.D., (physics), Wayne State University	Scientist, Science Applications, Inc.	Research in properties of liquid helium; coherent light propagation through the near earth atmosphere; micrometeorological structure of the near earth atmosphere; field test evaluation of laser/eo systems
3. Dr. Silverio Pedro Almeida (1933-) Hudson, Mass. B.A., Clark University; M.S., M.I.T: Ph.D. (physics), Cambridge University	Associate professor, physics, Virginia Polytechnical Institute	Research in coherent optics, holography, pattern recognition, image analysis, light scattering, elementary particles
4. Dr. Marcelo Alonzo (1921-) Cuba Ph.D. (physics), University of Havana	Director, Science and Technology, Organization of American States, Washington, D.C.	Research in nuclear physics and quantum theory

5.	Dr. Raymond Angelo Alvarez, Jr. (1934-) Ph.D., Stanford	Head of laboratory, Lawrence Radiology Lab, Berkeley	Research in nuclear physics
6.	Dr. Gilbert L. Cano (1932-) New Mexico Ph.D. (mathematical physics), New Mexico State University	Sandia Labs, Albuquerque	Research in nuclear physics
7.	Dr. Jose Luis Martinez Cortez (1938-) Mexico Ph.D., University of Michigan	Lawrence Radiology Lab, Berkeley	Research in atomic physics
8.	Dr. Humberto Fernandez-Moran (1924-) Venezuela M.D., University of Munich; M.D., University of Caracas; M.S., Ph.D., University of Stockholm	Professor of biophysics, University of Chicago	Research on the effects of radiation on various tumors; electron microscopy of cell membranes; electron and neutron diffraction; served on the Atomic Energy Commission and the first Inter-American Symposium on Nuclear Energy
9.	Leonidas D. Marinelli (1906-) Argentina M.A., Columbia University; Janeway Medal, American Radium Society	Associate Professor, Radiology, University of Chicago	Research in dosimetry and uses of radioactive isotopes in industry; clinical therapy; radiation protection; spectometry of low-level gamma radiation emitted by the human body; epidemiological investigations concerning effects of chronic radiation
10.	Dr. Ramiro A. Montalvo (1937-) Mexico Ph.D., Northwestern University	Geomet, Inc. Rockville, Maryland	Research in solid state physics
11.	Dr. Reynaldo Morales (1937-) Texas Ph.D., University of Texas	Los Alamos Scientific Laboratory	Research in nuclear physics
12.	Dr. Fernand Bernadino Moringo	Associate professor, physics, Caltech	Research in nuclear physics, beta-decay, and

	(1936-) Argentina Ph.D., Caltech Phi Beta Kappa		nuclear reaction theory
13.	Dr. Carlos Alberto Pampillo (1938-) Argentina Ph.D. (metals physics), Balseiro Institute of Physics	Research physicist, Materials Research Center Allied Chemical Co., Morristown, New Jersey	Research in strength and plastic deformation materials, polymers, and glasses; and in the fracture of structural material
14.	Dr. Victor Perez-Mendez (1923-) Guatemala M.S., Hebrew University, Jerusalem; Ph.D, Columbia University	Senior scientist, Lawrence Radiation Lab, Berkeley; lecturer, Extension Division, U.C., Berkeley	Research in elementary particles; meson-nuclear forces; developed electronic and nuclear instrumentation; automatic analysis of nuclear data by computers
15.	Andres D. Sanchez (1933-) New Mexico M.A., University of Colorado	Casa de la Raza, Berkeley Unified School District, Berkeley, California	Nuclear physics

Chemistry/Biochemistry/Chemical Engineering

Prominent Hispanic-Americans in the fields of chemistry, biochemistry, and chemical engineering include:

Name, Place and Date of Birth, Education and Awards	Position	Research, Publications, Contributions
1. Dr. Adolfo Aguila (1928-) Ph.D., University of Buenos Aires	Group Leader, Celanese Chemical Co., Texas	Industrial chemistry
2. Sergio Ajuria-Garza (1936-) Mexico M.S., UC Berkeley	The Anaconda Co., Tucson	Solvent extraction chemistry
3. Dr. Ismael Almodovar (1932-) Puerto Rico Ph.D. (nuclear and inorganic chemistry), Carnegie Tech	Coordinator of Scientific Affairs, Office of the President, University of Puerto Rico; N.S.F. lecturer	Research in solid state chemistry and physics, nuclear physics, geochemistry

4.	Jose Juan Alvarez (1948-) Texas M.A., Sam Houston State University	Carnation Co., Van Nuys, California	Analytical chemistry
5.	Robert Alvarez (1921-)	Analytical chemist, Spectrochemical Analysis Section, National Bureau of Standards	Development of stable isotope dilution techniques for determination by spark source mass spectrometry; chemical preconcentration techniques applied to spectrochemical analysis; optical emission and X-ray fluorescent methods of analysis
6.	Dr. Peter X. Armedarez (1930-) California Ph.D. (physical chemistry), University of Arizona	Professor, physics and chemistry department, Brecia College, Kentucky and chairman of the division of natural science and math	Research in molecular spectra and structure of inorganic complexes; low temperature emission and absorption spectra of chromium complexes; infrared studies and normal coordinate analyses of metal chelate compounds
7.	Dr. Conrado Federico Asenjo (1908-) Puerto Rico Ph.D. (phytochemistry, biochemistry), University of Wisconsin Grand Prize, Physico-Chemical Science, Puerto Rico Academy of Arts and Sciences; Honor Plate Award, Dietetic Association of Puerto Rico	Associate dean, University of Puerto Rico School of Medicine	Research in chemical composition of economic and medicinal plants; vitamin survey of tropical foods; food yeast nutritional value; fat absorption in sprue, folic acid deficiency, biological evaluation of proteins; public health nutrition; nutritional surveys
8.	Dr. Santiago Grisolia (1923-) Spain M.D., Medical School, University of Valencia	Professor of medicine and biochemistry, University of Kansas; investigator, American Heart Association	Research and publications in phosphoglycerate metabolism; carbamyl and acetyl amino acids metabolism; substrate induced enzyme inactivation
9.	Dr. J. V. Martinez (1932-) Arizona Ph.D., Oregon State University	Division of Physical Research, U.S. Engineering Research and Development Administration, Washington, D.C.	Radiation scattering
10.	Dr. Jorge Louis Padron (1931-) Cuba Ph.D. (biochemistry, bacteriology), Univer-	Professor and head of department of chemistry, Drury College; Fullbright lecturer in Spain and Ecuador; NATO Fellow	Research in bacterial physiology, altered metabolic pathways, accompanying chloramphenical resistance in staphylococcus

	sity of Oklahoma	Oxford	aeurus, glucose acetoacetate condensate as an antidiabetogenic factor
11.	Dr. Carl P. Ruiz (1934-) Ph.D., UC Berkeley	Technical specialist, Valecitos Nuclear Center General Electric Co.	Research in heavy element nuclear decay scheme studies; measurement methods of nuclear fuel burn up and heavy element isotopic composition; alpha and gamma spectroscopy; neutron cross-reaction; half-life and thermal neutron fission yield measurements; chemical separation methods; spent nuclear fuel and radioisotopic chemical process studies

Other well-known persons in the fields of chemistry, biochemistry, and chemical engineering include: (Most of these listings are taken from the *Directory of Spanish Surnamed and Native Americans in Science and Engineering*).

1. Dr. Tony Luis Archuleta (b. New Mexico), Chemical Abstracts Service, Columbus, OH
2. Bert H. Baca (b. New Mexico), University of California Los Alamos Scientific Lab, NM
3. Dr. Carlos Enrique L. Bamberger (b. Germany), Oak Ridge National Laboratory, TN
4. Dr. Raymond Barreras (b. New Mexico), Carver Research Foundation, Tuskegee Institute, AL
5. Richard Barrueto (b. Guatemala), Boeing Aircraft Co., WA
6. Dr. Francisco Bonilla (b. Costa Rica), Interpace Corp., Los Angeles, CA
7. Ross C. Caballero (b. California), Sanitation Districts, County of Los Angeles
8. Arturo Limon Cardenas (b. Texas), Goodyear Atomic Corp., Piketon, OH
9. Ricardo Cardenas (b. Texas), Texaco, Inc. Bellaire Research Labs, TX
10. Dr. Gabriel D. Castillo, Jr., U. S. Food and Drug Administration
11. Margarito Chavez (b. New Mexico), V. A. Hospital Research Labs, Tucson
12. Dr. Henry Cortez (b. Texas), PPG Industries, TX
13. Raymond Lincoln Costa (b. New York), Xerox Corp., Pasadena, CA
14. Benito De Luna, Jr. (b. Texas), Shell Chemical Co., TX
15. Dr. Ramon L. Espino (b. Cuba), Chemical Systems, Inc., NY

16. Ricardo Fernandez (b. Cuba), Gillette Co., IL

17. Dr. Emilio J. Gallegos (b. Colorado), Chevron Research, Richmond, CA

18. Dr. Edward Garcia (b. Connecticut), Hoffmann-LaRoche, Inc., NJ

19. Dr. Eugene Garcia (b. Mexico), Program Media Associated, Inc., Norwalk, CA

20. Eliseo V. Garcia (b. Cuba), Pacific G & E, Antioch, CA

21. Roberto G. Garcia (b. Texas), Alcon Laboratory, TX

22. Thomas Garcia-Borras (b. Spain), A. and E. Plastics Polymer Systems, Industry, CA

23. Dr. Alfredo Giner-Sorolla (b. Spain), Sloan-Kettering Institute, NY

24. Manuel Gomez (b. Colorado), U.S. Bureau of Mines, Denver

25. Juan Gonzalez (b. Texas), Texas Community Pesticides Study

26. Dr. Carlos Guerra (b. Peru), W. R. Grace and Co., MD

27. Henry C. Guerrero (b. California), CGS Computer Services, Claremont, CA

28. Conrado P. Guiterrez (b. New Mexico), Los Alamos Scientific Lab, NM

29. Andres Hernandez (b. Cuba), Wellman Power Gas, Inc., FL

30. Manuel Jimenez (b. Puerto Rico), Hoffmann-LaRoche, Inc., NJ

31. Arthur Jiminez (b. Mexico), Tenneco Chemical Co., Berkeley

32. Dr. Sigredo Maestas (b. New Mexico), Scientific Research Institute, New Mexico Highlands University

33. Abelardo Martinez (b. Texas), Stanford Research Institute, CA

34. Ferdinand Martinez (b. Mexico), Sperry Rand, MA

35. George M. Martinez (b. Colorado), U.S. Bureau of Mines, Reno

36. Victor M. Mendez (b. Texas), Southwest Research Institute, TX

37. George Molina (b. Bolivia), Gillette Research Institute, MD

38. Jose M. Molina (b. Texas), Alcon Labs, Inc., TX

39. Erick Montoya (b. Colombia), Hewlett-Packard, PA

40. Dr. Raul Morales (b. Honduras), Dupont Chemical Experimental Station, DE

41. Dr. R. F. Muraca (b. Pennsylvania), Western Applied Research and Development, San Carlos, CA

42. Dr. Jaime Ocampo (b. Colombia), American Cyanamid, NJ

43. John R. Prisco (b. New York), Araneida Inc., IN

44. Dr. Jose E. Ramirez (b. Cuba), U.S. Dept. of Agriculture, Philadelphia

45. Dr. Juan Ramirez-Munoz (b. Spain), Beckman Instruments, Fullerton, CA

46. Dr. Miguel F. Refojo (b. Spain), Retina Foundation, Boston

47. Arthur Rodriquez, Jr. (b. New York), Chemitron Corp., NY

48. Charles F. Rodriguez (b. Texas), Southwest Research Institute, TX

49. Dr. Herman Rodriguez (b. New York), Ciba-Geigy Pharmaceutical Co., NJ

50. Dr. Jose Rodriguez-Absi (b. Mexico), Research Foundation, Texas A & M

51. Octavio Romero (b. Mexico), Shell Chemical Co., TX

52. Dr. M. Gali Sanchez (b. Spain), W. R. Grace and Company, MD

53. Dr. Robert Sanchez (b. Colombia), Salk Institute, San Diego

54. Ulises C. Sanroma (b. Spain), Firestone Synthetic Fibers Co., VA

55. Gonzalo Segura, Jr. (b. Cuba), Philip Morris, Inc.

56. Hector Silva (b. Mexico), Westinghouse Electric

57. Gilbert Suarez (b. New York), Colgate-Palmolive Co.

58. Juan A. Tijerina (b. Texas), U. S. Food and Drug Administration

59. Dr. Eduardo Ugarte, United Medical Labs., Portland

60. Manuel J. Urizar (b. Nevada), Los Alamos Scientific Lab.

61. Dr. John Carlos Vigil (b. New Mexico), Los Alamos Scientific Lab.

62. Richard Villalobos (b. Arizona), Beckman Instruments, Fullerton, CA

Space Education

Dr. Louis D. Serrano, Education Specialist for the Jet Propulsion Laboratory in Pasadena, is one of the best known aerospace lecturers in America. Born in Rio de Janeiro of a Spanish father and a French mother, he studied at the University of Friburgo in Brazil, the Sorbonne in France and took his Ph.D. in philosophy and psychology at McGill University in Canada. He has held a variety of teaching positions at both the high school and college level and, as dean of the language department at Bosco Tech, was co-designer of the pilot program of a five-year high school-college science-vocational approach to education. He has been manager of the International Department of Warner Brothers Studios; served as the Spanish

and Portugese voice for Walt Disney; and has written a syndicated newspaper column on American life, "Letters From Hollywood." Among his projects is a book entitled *Our Wonderful World of Deception.*

Physiology/Neurophysiology/Cell Physiology

Name, Place and Date of Birth Education and Awards	Position	Research, Publications, Contributions
1. Dr. Ramon Alvarez-Buylla Spain Ph.D., Medical Academy of Science, USSR	Professor of physiology and director of Investigation and Advanced Studies, National Polytechnical Institute	Resin neuroendocrinic integration; mechanisms of homeostasis; conditioned reflexes
2. Dr. Carlos Edwards Eyzaquirre (1923-) Chile M.D., University of Chile	Professor of physiology and chairman of department, University of Utah College of Medicine	Research in physiology of nervous system; physiology of receptors and chemoreceptors; initiation of impulses in these areas
3. Dr. Rafael Lorente De No (1902-) Spain M.D., University of Madrid	Physiologist, Rockefeller Institute	Author of *A Study of Nerve Physiology*
4. Dr. George M. Padilla (1929-) Guatemala Ph.D. (zoology), George Washington University	Associate Professor, physiology and pharmacology, Duke University; Director, Babies Hospital Research Center, Wilmington, NC	Research in cell division synchrony; biophysical separation of cellular particulates; cell growth; comparative marine cellular physiology; cellular control systems in cell cycles

Mathematics

1. Dr. Larry Armijo (1938-) Texas Ph.D. (mathematics), Rice University	Senior staff engineer, Lockheed Aircraft, Houston	Research in classical and numerical analysis; differential equations and optimization techniques; operations research; biomedical engineering; radar meteorology
2. Jesus S. Cabera (1939-) Texas M.S., St. Mary's University	U. S. Air Force	Point-set topology

3.	Dr. Frederick Reyes Norwood (1939-) Mexico Ph.D. (applied mechanics), California Institute of Technology	Sandia Labs, Albuquerque	Applied mathematics

Pharmacology/Pharmacy

1.	Dr. Louis Winfield Duarte (1924-) Los Angeles, California D.Pharm., University of Southern California	Owner, Villa Real Pharmacy in East Los Angeles; Secretary-Treasurer, Villaduarte Corp.	
2.	Dr. Thomas Hernandez (1914-) Lafayette, Louisiana Ph.D., State University of Iowa	Chairman, department of pharmacology, Louisiana State University School of Medicine	Author (with R. A. Coulson) of *Biochemistry of the Alligator*; research on biochemistry and physiology of fluid and electrolytes; renal function; human testing of antimalarial drugs; carbohydrate and amino acid metabolism; nitrogen metabolism
3.	Tony Sierra (1924-) Mexico B.S. (chemistry and pharmacy), University of Arizona	Owner, Popular Drug Co., Calexico	President, Board of Trustees, Calexico Unified School District; Member, State Board of Education

Invention

1.	Edmund Galindo (1913-1959) Mexico Los Angeles City College	Co-founder, E. Galindo Co. and Nu-Hope Laboratories	Designed an ileostomy and ureterostomy bag

Meteorology

1.	Dr. José Angel Colon (1921-) Puerto Rico Ph.D., University of Chicago	Chief forecaster, U. S. Weather Bureau, San Juan Puerto Rico	Research in structure, formation, motion, and evolution of tropical hurricanes; air-sea interactions; redistribution of energy from ocean to atmosphere; formation and structure of Indian cyclones; Indian monsoon circulation

Volcanology/Tectonics

1.	Dr. Walter Alvarez (1940-) Ph.D. (geology), Princeton	Research associate, Lamont-Doherty Geological Observatory	Research in microplate and mountain belt tectonics; geological-archaeological studies; paleomagnetism, Alpine-Mediterranean region of North and South America

Biological Oceanography

1.	Dr. Angeles Alvarino de Leira (1916-) Spain D.Sc., University of Madrid	Fishery Research Biologist, National Marine Fisheries Service, La Jolla	Research in zooplankton, chaetognathae, siphonophorae, medusae, taxonomy, zoogeography; indicator organisms in water masses; fouling, sea fisheries; biology and ecology of thunnidae; discovered eight new species of chaetognathae, three of siphonophorae

Sociology

1.	Dr. Manuel Alers-Montalva (1920-) Puerto Rico Ph.D., Michigan State University	Sociologist	Research on human factors in technical development of Latin-American countries

Anthropology

1.	Francisco E. Aguilera (1943-)	Assistant professor, anthropology, Boston University	Research in Latin-American and Iberian social organization of rural agrarian peoples
2.	Theresa Tellez (1929-) New Mexico M.A., American University	Professional associate, Office of Foreign Secretary, National Academy of Sciences, Washington, D.C.	Science in ethnic societies

Psychology

1.	Dr. Uvaldo Palomares (1936-) Indio, California Ph.D. (educational psychology), University of Southern California	Co-director, Human Development Training Institute, San Diego; President, Institute for Personal Effectiveness in Children	Educational and emotional problems in preschool and elementary school children; designer of tests to accurately measure the aptitudes and abilities of Spanish speaking students

Geology

1.	Miguel Montes (1930-) Texas B.S., Texas A & M	Texas International Petroleum Corporation, Louisiana	Natural fuels

Engineering/Electronics/Computers

Prominent Hispanic-Americans in these fields include:

Art Arriola, a project engineer with the Naval Ocean Systems Center (NOSC) in San Diego. He works mainly in the area of digital design with an emphasis on the design and implementation of discrete component digital controllers, minicomputer interfaces, and automatic test equipment. Born in El Paso, Texas (both of his parents were originally from the Mexican state of Chihuahua), he received his B.S. in electrical engineering from the University of Texas at El Paso and is currently pursuing his Masters at San Diego State University.

Michael Gonzales Castañeda, a mechanical engineer with the computer science and engineering department of NOSC's Production and Fleet Support Branch. A native of New Mexico (father from Chihuahua, Mexico; mother from Texas), he has served as NOSC's Spanish-speaking coordinator and on their Summer Aid Student Program. He is currently a recruiter/advisor of the Technician Development Program, an equal employment opportunity personnel counselor, and a member of their Speaker's Bureau. (See How to Use Materials section). The recipient of a community service award in 1970, Castañeda was also All State V.F.W. Commander in 1969. One of his goals is to translate the works of the greater Mexican song writers into English.

Alfred M. Medrano is an electronics engineer at NOSC's Systems Design Branch. Born in the Los Angeles area, he received his B.S. with honors in electrical engineering from Cal Poly, Pomona.

Rosendo Naranjo, an electronics engineer at NOSC, was born in Cali, Colombia and took his B.S. at UCLA. Among his many accomplishments are the development of a new computer program for processing data which reduces turn-around time from three months to five days; and the design of a filming technique which costs $5000 and which replaced a sophisticated but inefficient $80,000 system. He also serves, in conjunction with the World Bank and the Inter-American Development Bank, as a consultant on South American projects involving mini-computer systems and microwave communication systems and has a special interest sharing the U.S.'s advanced technology with the developing countries of Latin America.

Dr. Frank M. Valenzuela, an electronics engineer at NOSC, works in the field of acoustics with an emphasis on experimental research. His responsibilities have included the development of advanced sonar systems and a submarine data acquisition system. He has also served as an instructor in engineering acoustics and mechanical engineering; implemented the Spanish Speaking Program for the Navy; and headed NOSC's Co-op Program for scientists and engineers. Dr. Valenzuela, both of whose parents came to the U.S. from Mexico, took his B.S. in mechanical engineering from the University of Arizona and his Ph.D. in engineering acoustics from Pennsylvania State University. He also received a fellowship from NOSC's Ph.D. Engineering Program.

In their Minority Profiles, NASA lists the following Hispanic-Americans among their employees:

Name and Place of Birth	Education and Awards	Position and Contributions
1. Mario Acuna, Ph.D. Argentina	M.S., electrical engineering, National University of Tucuman; Ph.D., space science, Catholic University of Amerida, Richardson Scholar at Davidson University	Principal investigator, Pioneer 11 fluxgate; Magnetometer Experiment, Goddard Space Flight Center
2. Henry H. Arnaiz Mexico	B.S., aerospace engineering, Cal Poly/Pomona M.S., mechanical engineering, University of Southern California	Aerospace engineer, Dryden Flight Research Center
3. Arturo B. Campos	B.S., electrical engineering, University of Texas	Section head, Power Distribution Sequencing Section, Johnson Space Center
4. Col. Gonzalo Fernandez Florida	B.S., engineering, U.S. Military Academy; M.S., astronautics, Air Force Institute of Technology; M.S., business administration, George Washington University	Assistant associate adminintrator for Center Operations (Systems Management) Headquarters
5. Orlando A. Gutierrez Cuba	B.A., mechanical engineering, Rensselaer Polytechnic Institute	Aerospace engineer, program manager, Lewis Research Center
6. Juan A. Juarez Arizona	B.S., electronics engineering, New Mexico State University	Electronics engineer Kennedy Space Center
7. Elena Melgares	B.S., biophysics Magna Cum Laude University of Houston	Aerospace engineer, Bioengineering Systems Development Branch, Johnson Space Center
8. Frank E. Penaranda Cuba	B.S., physics, Manhattan College M.S., physical sciences, Marquette University	Director, Resources and Management Systems Division, OAST Headquarters
9. Ruben Ramos Mexico	B.S., electrical engineering, University of Texas	Electronics engineer, Ames Research Center
10. Fidel R. Rul, Jr. Texas	B.S., mathematics, Texas A & M University	Deputy director, Goldstone Tracking Station

Other Hispanic-American engineers (taken from the *Directory of Spanish Surnamed and Native Americans in Science and Engineering*) are:

1. Jake I. Alarid (b. New Mexico), North American Rockwell
2. Humberto F. Alcantar (b. California), North American Rockwell, NASA Space Division
3. Manuel E. Alvarez (b. California), North American Rockwell
4. Jaime Chaparro (b. Chile), Southern Engineering Co. of Georgia
5. Ernest Cortes (b. California), Lockheed Electronics
6. Felix Fernandez (b. Cuba), M. W. Kellogg Company
7. Victor Garcia (b. New York), Litton Ship Systems
8. Luis Garza (b. Texas), Southwest Research Institute
9. Enrique Gomez (b. Texas), General Dynamics
10. Julian Juantorena (b. Cuba), Ledoux and Company Metallurgical Laboratory
11. Henry J. Martinez (b. California), North American Rockwell
12. Manuel M. Puente (b. Spain), Fluor Corp.
13. Joseph Zavala (b. Illinois), Advance Transformer Co.

APPENDIX A

MOSLEM AND JEWISH SCIENTISTS OF MEDIEVAL SPAIN

Circa 900-1200

Abu'l Qāsim Maslamahal-Majrītī (b. ?, d. circa 1007), astronomer and occulist of Madrid, the first Hispanic-Muslim scientist of note, was one of the first to introduce study of the sciences, especially mathematics and alchemy, to the western part of the Islamic world. Among his written works were a treatise on the astrolabe; a commentary on Ptolemy's Planisphaerium; a commercial arithmetic book; and, it is thought, one on the generation of animals. He is considered to be the scholar who added tangent functions to astronomical tables.

Avicenna (980-1037), whose *Canon* is the most widely read medical book ever written. Regularly published through the middle of the 17th century, it is still used in some Eastern countries.

Elzarakeel Al-Zarqālī (Arzachal) (b. circa 1029, d. circa 1087), an astronomer and mathematician who, while working in Cordova and Toledo, invented an improved astrolabe; became the first person to prove the motion of solar apogee with ref-

erence to the fixed stars; edited the Toledan astronomical tables; and explained the construction of trigonometrical tables.

Abraham Bar Hiyya (1070-1136), Barcelona-born Jewish mathematician and astronomer who pioneered the spread of Arabic science to the Western world. His mathematical and philosophical writings were very important to the growth of Western science.

Abu Marwan Ibn Zuhr (Avenzoar) (b. circa 1091, d. circa 1161), physician of Seville and teacher of the great scientist Averroes, attempted to keep medicine and chemistry united and wrote books on therapeutics, hygiene, foodstuffs, and various pathological conditions. Two generations of great physicians were members of his family, among them a woman (unusual in those times) noted for her healing arts and the greatest of the Andalusian clinicians, Abu Marwan 'Abd Al-Malik.

Abu 'Abd Allah Muhammad Idrisi (1099-1166), a geographer from Ceuto who, in writing a description of the world, divided it into seven climatic zones and recognized its sphericity. He also wrote a geographical encyclopedia (the romantically named *Pleasure of Men and Delight of Souls* and treatises on botany and materia medica.

Ibn Ezra (b. circa 1089, d. 1164), the great Toledo-born Jewish philosopher and translator who was immortalized by Robert Browning in his *Rabbi Ben Ezra*. A prolific writer (on math, astrology, calendars, and astrolabes), he was interested in magic squares and the mystical properties of numbers; explained the decimal system of numeration; helped spread the Moslem's rationalistic scientific approach among the Jews of Christian Europe; and greatly influenced both the Jews and the Christians of the period.

Al-Gafigi (b. ?, d. 1165), was a physician and botanist born in Ghafig, Spain. He gathered and described Spanish and African plants and was the first person to describe yellow amber and sal ammoniac.

Abu Bakr Ibn Tufail (b. ?, d. circa 1185), was a physician and philosopher who practiced near Granada and whose writings included a natural classification of science and a discussion of spontaneous generation.

Abu Zakariya Ibn Al-'Awwam (flourished, Seville, end of 12th century), authored the most important medieval work on agriculture, *The Book of Agriculture*. It contained observations on soils and manures, grafting, and numerous plants.

Muhammad Ben 'Ali Ibn Farah Al Safra (flourished circa 1199), a botanist who collected and studied plants in meridional Spain and founded the Botanical Garden of Guadiz.

Maimonides (or Moses ben Maimon) (b. Cordova 1135, d. 1204), the physician who has been called the most influential Jewish philosopher since Moses. His writings influenced the medicine of his time as well as many later Christian philosophies. He studied art, science, medicine, philosophy, and literature with Arab instructors; Hebrew and Jewish learning with his father. Traveling to Egypt, he became Saladin's personal physician and wrote medical books on such subjects as asthma, diet, and poisons and their cures. A believer in what is now called psychosomatic medicine, he advocated hygiene and the healing power of nature. A student of astronomy, he was one of the earliest scientists to discredit astrology.

Ibn Bajja (b. Saragossa 1106, d. circa 1138), was an astronomer and philosopher who wrote on materia medica. A leader in the movement to revise Ptolemy through systematic research, his works influenced many of the great scientists who followed him.

Abu'l-Walīd Muhammad ibn Rushd (Averroes) (b. Cordova 1126, d. 1198), was an authority on religious law, medicine, and philosophy and the scion of a family known for the number of judges and religious scholars it produced. The works of this man, one of the most influential of Moslem thinkers and a noted commentator on Aristotle, survive today in Latin and Hebrew translations.

Other famous scientific figures of those days include Hasday ben Shaprūt, the Jewish scholar who translated the *Materia Medica* of Dioscorides; 'Arīb ibn Sa'd al-Kātub, author of a noted work on gynecology; Abu'l-Qāsimal-Zahrāwī (the Latin Albucasis), the greatest Moslem figure in surgery; Ibn al-Baitār, who listed all that was known about pharmacology and added some 300 new drugs; and Zacaria Al-Awan, whose scientific study of arboriculture and horticulture laid the foundation for future works on the subject.

Circa 1200-1400

Judah ben Solomon Ha-Kohen Ibn Matqah (b. Toledo circa 1219, d. ?), an astronomer and philosopher whose encyclopedic work, *The Search for Wisdom*, (written in Arabic and later translated into Hebrew) discussed Aristotelian logic, physics and metaphysics, religion and math.

Muhyi al-din Al-Maghribi (flourished 13th century), a mathematician and astronomer whose works revealed a great knowledge of Chinese astronomy.

Abu Muhammad Ibn Al-Baytar (1197-1248), the greatest botanist and pharmacologist in all Islam.

Abu Abdallah Ibn Al-Raqqam (b. ?, d. 1315), who wrote articles on scientific instruments and compiled the astronomical tables for Andalusia.

Isaac Ben Joseph Ben Israel of Toledo (b. ?, d. circa 1330), an astronomer whose writings represent the height of medieval Jewish astronomy. (His works included complete solutions of right-angled spherical triangles).

Ibn Al-Khatib (b. Loja 1313, d. circa 1374), a physician who considered the possibility that disease is contagious and wrote on such subjects as eye disease, fever, surgery, pediatrics, aphrodisiacs, sex, cosmetics, medical history, and travel.

APPENDIX B

STATISTICS REGARDING THE REPRESENTATION OF HISPANIC-AMERICANS IN SCIENCE

1. Only about 100 of the 10 million Mexican-Americans living and born in the U.S.A. hold science Ph.D.'s (Entry 14, Bibliography)

2. Of the 42,000 medical students in this country in 1971-72, 247 were Mexican-American, 76 mainland Puerto Rican. (Entry 7, Bibliography)

3. Of the 17,305 dental students in this country in 1971-72, 93 were Mexican-American, 26 mainland Puerto Rican. (Entry 7, Bibliography)

4. In Chicago, where some 500,000 Spanish-surnamed persons lived in 1970, only 28 of the 4253 persons attending hospital-based schools of nursing were Spanish-surnamed. On the other hand, 45.5% of those training to be practical nurses (a poorer paid, less specialized position) were of Hispanic origin. (Spanish-surnamed refers only to the origin of a person's name and, thus, may include women who have assumed their husbands' names). (Entry 7, Bibliography)

5. Only 1.2% of American engineering students in 1973 were of Spanish origin. (Entry 20, Bibliography)

APPENDIX C

PROGRAMS DESIGNED TO MEET THE HEALTH SERVICE NEEDS OF AND RELIEVE THE HEALTH WORKER SHORTAGE AMONG HISPANICS

1. In June, 1970, the Office of the Special Assistant on Health Needs of Spanish-surnamed Americans was established in the U.S. Department of Health, Education and Welfare. They are involved in implementing a comprehensive health services program for Hispanics.

2. The Comprehensive Health Manpower Training Act of 1971 allows the federal government to provide funds to encourage the participation of socio-economically disadvantaged students in health science schools. (Companion Act: Nurses Training Act of 1971).

   This Act authorized the creation of the Office of Health Manpower Opportunity (in the Bureau of Health Manpower Education). Dr. Henry Herrera of that office is Special Assistant for Spanish-surnamed Concerns. Among the activities of this office have been:

   a. Funding the Bay Area Raza Coalition for Health, a group of community-controlled family health clinics (San Francisco Bay Area). High School and college students are also brought to these clinics to learn about health careers and to receive educational counseling and tutoring.

   b. Funding the New York College of Podiatry which works with Puerto Rican students (in New York and other parts of the Northeast) interested in careers in podiatry and helps provide bilingual, bicultural podiatric education.

   c. Med-Start Program in Tucson, Arizona

   d. Black Indian Chicano Coalition in Omaha, Nebraska

   e. Funding to recruit and retain minority students in the health sciences.

APPENDIX D

HISPANIC-AMERICAN PROFESSORS

Name	School	Field
1. Dr. Daniel Acosta	University of Texas	Pharmacy
2. Dr. Juana Luisa Acrivos	San Jose State	Chemistry
3. Dr. Guillermo A. Aguayo	University of Puerto Rico	Chemical engineering
4. Dr. Jose Ramon Alcala	Wayne State University	Anatomy
5. Dr. Jorge Antonio Aldrete	University of Colorado	Anesthesiology
6. Dr. Anita Alvarado	University of New Mexico	Anthropology
7. Dr. Laurence Richards Alvarez	University of the South	Mathematics
8. Dr. Armando Carlos Angel	Pima College	Chemistry
9. Dr. Vincent Anselmo	New Mexico Highlands University	Chemistry
10. Dr. Gina Arce	California State University, Fresno	Botany
11. Dr. Efriam Pacillas Armencariz	University of Texas	Mathematics
12. Dr. Lucio Arteaga	Wichita State University	Mathematics, statistics
13. Dr. Steven Arvizu	California State University, Sacramento	Anthropology
14. Dr. Alonzo C. Atencio	University of New Mexico	Medicine, hormone synthesis
15. Vincent E. Avarez	UC Santa Barbara	Chemistry
16. Dr. Ernesto J. Baca, Jr.	College of Santa Fe	Chemistry
17. Oswald G. Baca	University of Kansas	Microbiology
18. Dr. Alfredo Banos	UC Los Angeles	Physics
19. Dr. Hugo Bargos-Guevara	University of Illinois	Anthropology
20. Dr. Ruben Gerado Barrera	University of Illinois	Physics
21. Dr. Jorge Raul Barrio	University of Illinois	Chemistry

22.	Dr. Carlos A. Bonilla	Colorado State University	Biology, physical biochemistry
23.	Byron C. Burros	California State University, Long Beach	Chemistry
24.	Dr. Joaquin Bustoz	University of Cincinnati	Mathematics
25.	Dr. Frank Cabera	Benedict College	Chemistry
26.	Jose G. Canchola	University of Texas Medical School	Public health, pediatrics, epidemiology
27.	Dr. Raul Cano	California State Polytechnic College, San Luis Obispo	Biological sciences
28.	Dr. Manuel Carlos	UC Santa Barbara	Anthropology
29.	Dr. Albert Joseph Castro	San Jose State	Chemistry
30.	Dr. Antonio E. Colas	University of Wisconsin Medical School	Biochemistry
31.	Dr. Eugene H. Cota-Robles	Pennsylvania State University	Microbiology
32.	Dr. Orlando Cuellar	University of Utah	Biology
33.	Dr. Jaime Delgado	University of Texas	Pharmacy
34.	Dr. A. F. Diaz	UC San Diego	Chemistry
35.	Albert C. D'Silva	Oregon Graduate Center	Engineering/materials science
36.	Dr. Ruben Duran	Washington State University	Microbiology, genetics, physiology
37.	Andres Estrada	Pan American University	Chemistry
38.	Dr. Hector Farias, Jr.	University of North Carolina Medical School	Anthropology, medical education
39.	Dr. Jack E. Fernandez	University of South Florida	Chemistry
40.	Dr. Rene Franco	El Paso Community College	Environmental engineering
41.	Juan M. Gallegos	Catholic University of America	Chemistry
42.	Dr. Tony Gallegos	New Mexico Highlands University	Biology
43.	Dr. Jose D. Garcia, Jr.	University of Arizona	Physics

44.	Dr. Ricardo Gomez	California Institute of Technology	Physics
45.	Dr. Ciriaco Q. Gonzales	College of Santa Fe	Biology
46.	Dr. Richard Griego	University of New Mexico	Mathematics
47.	Dr. Nicolas Herrera	St. Bernard College	Chemistry
48.	Dr. Joe Ibanez, Jr.	University of Houston	Chemistry
49.	Gabriel A. Infanto	Texas A & M	Chemistry
50.	Dr. Vincente Llamas	New Mexico Highlands University	Physics
51.	Dr. Carlos Llano	University of the Americas	Chemistry
52.	Dr. Antonio Lopez-Roman	Louisiana State University	Chemistry
53.	Dr. Edward Macias	Washington University	Chemistry
54.	Arthur Mares	College of Santa Fe	Biology
55.	Diana Marines	Michigan State University	Natural science
56.	Dr. Alberto M. Martinez	University of Illinois	Chemistry
57.	Elsa Diana Martinez	University of Texas Medical School	Chemistry
58.	Dr. Jacinto Martinez	Eastern Illinois University	Zoology
59.	Samuel Martinez, Jr.	University of Tulsa	Chemistry
60.	Zaida C. Martinez	Florida State University	Chemistry
61.	Dr. Marino Martinez-Carrion	Florida State University	Chemistry
62.	Dr. Carmen Mercado	Hunter College	Chemistry
63.	Dr. Miguel Medina	University of Texas Medical School	Pharmacology
64.	Dr. Jaime Maya	Eastern Illinois University	Zoology
65.	Dr. Gustavo Morales	Baylor University	Geology
66.	Dr. John A. Narvarte	University of Texas	Mathematics
67.	Dr. Luis Gabriel Navar	University of Alabama	Physiology, biophysics
68.	Dr. Alberto Olivares	Texas A & I	Chemistry

69.	Dr. Maria Ortiz	California State Polytechnic College, San Luis Obispo	Biological Sciences
70.	Dr. Andrew Pacquet	Texas Christian University	Biology
71.	Dr. Jose Rafael Padro	University of Puerto Rico	Mathematics, statistics
72.	Dr. John Carlos Perez	Texas A & I	Biology
73.	Dr. Steven Perez	University of South Florida	Chemistry
74.	Dr. Ramon Pinon, Jr.	UC San Diego	Biology
75.	Jose Juan Rabelo	Rutgers College	Biochemistry
76.	Dr. Philip Reyes	University of New Mexico School of Medicine	Chemistry
77.	Dr. Miguel Rios, Jr.	California State Polytechnic College, Pomona	Physics
78.	Evelyn Rivera	Michigan State University	Natural science
79.	Dr. Juan Guadalupe Rodriquez	University of Kentucky	Entomology
80.	Lorraine D. Rodriquez	University of Kentucky	Microbiology
81.	Dr. Sergio Rodriquez	Purdue University	Physics
82.	Dr. Hector Rubalcava	University College, Dublin	Chemistry
83.	Dr. Manuel Ruiz-Urbieta	Texas Tech	Mechanical engineering
84.	Emigdio Jesus Salmon	University of Connecticut	Chemical engineering
85.	Dr. Julian Samora	University of Notre Dame	Anthropology
86.	Dr. David A. Sanchez	UC Los Angeles	Mathematics
87.	Dr. Gilbert Sanchez	New Mexico Institute of Mining and Technology	Biology
88.	Dr. Antonio Sandoval	University of Missouri	Chemistry
89.	J. M. Santillan-Medrano	Utah State University	Soil chemistry
90.	Ricardo Silva	San Fernando Valley State	Chemistry
91.	Dr. Frank J. Talamantes	UC Santa Cruz	Biology
92.	Dr. Richard Tapia	Rice University	Mathematics
93.	Dr. George Trevino	Del Mar College	Physics

94.	Dr. Henry Truebo	University of Illinois	Anthropology
95.	Edward Trujillo	University of Utah	Biology
96.	Dr. Vincente Villa	New Mexico State University	Biology
97.	Dr. Juan Villamarin	University of Delaware	Anthropology
98.	Dr. Juan d'Guerabide	UC San Diego	Biology
99.	Conchita de Ortiz Zuazaga	University of Minnesota	Chemistry

APPENDIX E

OTHER HISPANIC SCIENTISTS AND THEIR CONTRIBUTIONS
(most of these names have been taken from the *Mi Raza* publication)

Name	Contribution
1. Dr. Fernando Alba	Movement of particles in a ring of radiation (1947)
2. Jose Antonio Alzate	Invented a cotton gin 20 years ahead of Eli Whitney (1729)
3. Emma Apodaca	Laboratory preparation of information in systems and tests for Space Division, Downey
4. Adolfo Camacho	First neotypo which revolutionized graphic arts (1945)
5. Arturo Campos	Senior electronic engineer, manager of prime contract development of lunar module electrical power distribution, NASA
6. Rodolpho Steven Castaneda	Inventor of circular motor internal combustion engine (1963)
7. Herbert De Crote	A light control (1945)
8. Ernesto Cardona de la Parra	Extraction of seventh root of a 63 digit number in 20 minutes through mental processes; a world record (1969)
9. Jaime de la Rosa	Manual control used on all Apollo systems (1970)
10. Carlos Finlay	Discovery of yellow fever transmitting agent (1914)
11. Enrique Valle Flores	New mathematical concepts (1900)

12.	Manuel Gonzalez Flores	Inventor of two building construction processes (1944)
13.	Antonio Ortega Franco	Medical technology, Warner Lambert Pharmaceutical Company
14.	Jorge Lopez	Responsible for physical assembly (paper to physical wiring) in the production of the Apollo
15.	Antonio Mendez	Sugar refinement (1875)
16.	Rafael Mendoza	M-1 and M-2 rifles; Mendoza machine gun (1911-12)
17.	Jose Mireles	Electrostatic transformer (1947)
18.	Felipe Padea	Designer of metal parachutes used by astronauts (1970)
19.	Octavio Peralta	Electric Peralta valve (1948)
20.	Manual L. Perusquia	A stereophonic phonograph (1954, 1957)
21.	Jose Salazar	Engineer on North American Rockwell's Apollo program
22.	Pedro C. Sanchez	New earthquake theory (1930)
23.	Javier Barros Sierra	Author, *Treatment of Differential and Integral Calculus* (1940)
24.	Ovidio Farga Torrente	Combination telephone-television (1969)
25.	Francisco Valenzuela	Valenzuela engine valve (1948)
26.	Dr. Manuel Sandoval Vallarta	Math and physics, the theory *Lemaitre Sandoval Vallarte*, relativity and naturalization of radiation
27.	Richard Thomas Zarvala	Mathematics

BIBLIOGRAPHY

1. Addison, Anthony, ed. *Where: A Family Book of Knowledge.* London: Octopus Books, 1964

2. Asimov, Isaac. *Asimov's Biographical Encyclopedia of Science and Technology.* Garden City, New York: Doubleday and Company, 1964.

3. Bernal, J. D. *Science in History.* London: C. A. Watts and Co., Ltd., 1954.

4. Cattel, Jaques, ed. *American Men and Women of Science.* New York: Jacques Cattel Press/R. R. Bowker Company, 1972.

5. Debus, Allen G., ed. *World Who's Who in Science-From Antiquity to the Present.* Chicago: Marquis-Who's Who Inc., 1968.

6. Degnan, James P. "Sympathy Vs. Standards: Teaching the Underprepared", *Report on Teaching, Change Magazine*, No. 6, Vol. 8 (July 1976). New Rochelle, N. Y., Educational Change, Inc., 1976, pps. 16-19.

7. Duval, Merlin K., M.D., "Latinos and Health Care: The Quest for Equity", an address presented at the National Health Manpower Education Conference for Spanish Surnamed, Saturday, October 21, 1972, Chicago, Illinois.

8. *International Who's Who-1976-77*, 40th Edition. London: Europa Publications, Ltd., 1976.

9. Lansing, Marion. *Liberators and Heroes of South America.* Boston: L. C. Page & Co., 1953.

10. Lincoln, C. Eric. "Equalizing the Opportunity to Learn", *Report on Teaching, Change Magazine*, No. 6, Vol. 8 (July 1976). New Rochelle, N.Y., Educational Change, Inc., 1976, pps. 60-63.

11. Lopez, Lino M. *Colorado Latin American Personalities.* Denver: privately published, 1959.

12. Martinez, Jose V., Ph.D. *Directory of Spanish Surnamed and Native Americans in Science and Engineering.* Rochester, N. Y.: privately printed: 1972.

13. Martinez, Jose V., Ph.D. "Statement for the Hispanic-American Minority Group, The Society for the Advancement of Chicanos in Science and the Society of Hispanic Professional Engineers Before the Special Subcommittee on the National Science Foundation of the Committee on Labor and Public Welfare, United States Senate, April 21, 1975." Washington, D.C.: U. S. Government Printing Office, 1975.

14. _____. Minority Profiles. NASA

15. *Mi Raza*, a newsletter.

16. Morison, Samuel Eliot. *Christopher Columbus, Mariner.* Reader's Digest Family Treasury of Great Biographies. Pleasantville, N. Y. 1970.

17. Morland, Nigel. *Science in Crime Detection.* New York: Emerson Books, Inc., 1958.

18. Nasr, Seyyed Hossein. *Science and Civilization in Islam.* Cambridge, Mass.: The Harvard University Press, 1968.

19. Ortiz, Antonio Dominguez. *The Golden Age of Spain.* New York: Basic Books, Inc., 1971.

20. Outstanding Americans of Mexican Descent (Posters). Menlo Park, Ca.: Educational Consulting Associates, 1970.

21. _____. "Racial Minorities in the Scientist and Engineer Population," *Science Resources Studies Highlights.* Washington, D.D.; National Science Foundation, September, 1975.

22. Ronan, Colin. *Lost Discoveries.* London: McGraw-Hill Book Company, 1973.

23. Sarton, George. *The History of Science and the New Humanism.* New York: George Braziller, Inc., 1956.

24. Sarton, George. *Six Wings: Men of Science in the Renaissance.* Cleveland: The WorldPublishing Company, 1966.

25. Sedgwick, W. T. and Tyler, H. W. *A Short History of Science.* New York: The Macmillan Company, 1917.

26. Singer, Charles. *From Magic to Science.* New York: Dover Publications, Inc. 1958.

27. Smith, Alan G. R. *Science and Society in the 16th and 17th Centuries.* New York: Science History Publications, 1972.

28. Stevenson, Lloyd G., M.D., Ph.D. *Nobel Prize Winners in Medicine and Physiology (1901-1950).* New York: Henry Schuman, 1953.

29. _____. "Trapezoid Buildings: Unknown Culture Found in Brazil". San Diego: The San Diego Union, February 13, 1977.

30. *The World Almanac and Book of Facts, 1977.* New York: Newspaper Enterprise Association, Inc. 1976.

ASIAN CONTRIBUTIONS TO SCIENCE, ENGINEERING, AND MEDICINE

Prepared by

Tetsuyo Kashima

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Dr. Chien-Shiung Wu

IMPORTANCE OF RECOGNIZING MINORITY CONTRIBUTIONS

While the impact of the West on our instructional programs has long been recognized, the contributions of Eastern civilizations have received but little attention. Because people outside the Anglo-Saxon mainstream are seldom accorded the same respect given their non-minority counterparts, their achievements often go unrecognized and, as a result, students are not given the opportunity to study and appreciate their work. Progress cannot be--and should never be--attributed to the contributions of any one country or group of people. It is, rather, a credit to the efforts of men and women from every known race, religion, culture, and civilization.

CONTRIBUTIONS OF JAPANESE AND CHINESE SCIENTISTS AND ENGINEERS

> The intellectual appetite of the Japanese people may be counted as one of their virtues and their interest in the unknown is particularly strong. Thus, even during the 250 years when the country was closed to the outside world*, the study of Western science, primarily in the medical field, was pursued by a certain number of people through Nagasaki, the only city permitted at that time to conduct foreign trade.
>
> In mathematics, although the figures were completely different from those used in the West, great progress was achieved in certain fields, and as early as the 17th century, the theory of differential and integral calculus had already been discovered.
>
> This love of learning of the Japanese people, coupled with an academic level which was extremely advanced, although limited to a narrow sphere, provided the conditions necessary, once the Meiji government introduced Western learning into the country, to bring about an amazing dissemination of general education in various fields of academic endeavour. For example, Dr. Hideyo Noguchi, who was destined to become a world famous bacteriologist in tropical diseases....., started from humble beginnings as the son of a very poor farmer. (*Japan in Transition*, Ministry of Foreign Affairs, Japan. 1975).

During this Meiji period (1868-1912) major technological progress was made in the improvement of strains of rice, cross-pollination, cultivation, irrigation, and fertilization. This was made possible by the now open communication between clans and villages, by subsidies, and by the government-fostered development of more modern tools and production methods.

The present emperor of Japan also has a strong interest in science, particularly marine biology and botany. He maintains a lab within the grounds of the Imperial Palace and has collaborated on such scientific works as *The Sea Shells of Sagami Bay* and *Nova Flora Nasuensis*. He has made great progress in the study of the hydrozoa, one of the most primitive forms of life and is also known for his studies of the plant life in the vicinity of Nasu in Tochigi Prefect.

*ended in the mid-19th century

The scientific and technological contributions made by people of Japanese--and Chinese--ancestry are far too numerous to list here. The following are but a few of these important accomplishments:

ASTRONOMY

As early as 400 B. C., Shih Sen, Wu Hsien, and Kan Te constructed celestial charts (using the modern coordinate system referenced to the equator) which accurately described the positions of more than 1500 individual stars. The first Chinese eclipse records date back to 1361 B.C. and their list of novae and super-novae details some 90 of these events between 1400 B.C. and 1690 A.D. (Only three super-novae have ever been recorded and the first of these, the origin of the Crab Nebula in Taurua, was recorded only by Chinese and Japanese astronomers in 1054 A.D.) They listed 581 comets between 1600 B.C. and 1600 A.D. and, as early as 635 A.D., noted that the tails of comets point away from the sun. Their many recorded observations of Halley's Comet--the earliest in 467 B.C.--helped modern astronomers approximate its orbit. Meteors and meteorites were also listed, as were the appearance of sun spots (phenomena they observed as early as 28 B.C.).

Chang Heng (78-139 A.D.), one of the greatest Chinese scientists, not only excelled in astronomy but in mathematics (calculating the value of pi), engineering, philosophy, poetry, geography, painting, and seismography. Among his many inventions was a water-driven planetarium. Kuo Shou Ching (1231 A.D.-1316 A.D.), the astronomer-mathematician believed to have introduced spherical trigonometry to China, is remembered for having determined the winter solstice of 1280 A.D.

ENGINEERING, INVENTION, AND TECHNOLOGY

The construction of the Great Wall of China, one of the finest engineering feats of all time, was the responsibility of Meng T'ien (circa 221 B.C.). An engineer and military general, he predicted that the major part of the wall could be built in seven years. Thanks to his scientific genius and talent for leadership, this dream became a reality. (Another great feat--one of hydraulic engineering--was the construction, starting in the 5th century B.C., of the 650 mile Grand Canal connecting Tientsin and Hangchow.) Also quite notable was the work of Tsu Ch'ung-Chih (430 A.D.-501 A.D.), an excellent mathematician and mechanic who constructed a motor boat and invented (or revived) a south pointing vehicle and of Shen Kua (1030 A.D.- ?), an astronomer-mathematician who included in his writings the first descriptions of the magnetic needle and of movable type for use in printing.

A listing of other Chinese firsts includes the invention--by Chuko Liang in 232 A.D.--of the wheelbarrow (which was not known in Europe until about 1250 A.D.). Paddle-propelled boats were being used in China nearly 1000 years earlier than in the West, as were mill water-wheels. A buddist monk, I-Hsing, and his colleagues designed the works of the first mechanical clock around 723 A.D. Tshai Lun, in 105 A.D., invented a paper of bark, bamboo, and fishnets; book printing started at least seven centuries before the time of the Gutenberg press. Gunpowder and the magnetic compass are Chinese inventions; they were also the only ancient people to design an efficient horse-harness. In 132 A.D., the mathematician Chang Hêng built the world's first seismograph, a fascinating device that, when the earth trembled, made a bronze ball fall into a container

from the mouth of a bronze animal. Systematic measurements of rainfall were also made at the time of the Norman Conquest of England and one, Hin Ying, in 135 B.C. (predating European discovery by more than 1000 years) noticed that snow flakes are always six-pointed.

Alchemy, one of the best known pseudo-sciences, was first mentioned (by Li Shao-Chün to the Emperor Han Wu Ti) in 133 B.C. and the first book on alchemy, *The Kinship of the Three*, was a Chinese one written in 142 A.D.

MATHEMATICS

Chang Ts'ang (c. 250 B.C.-c. 152 B.C.) wrote *Arithmetic Rules in Nine Sections* (China's greatest arithmetic classic) in which he gave the area of a segment of a circle as $\frac{1}{2}(c+a)a$ where c = chord and a = altitude of the segment. Liu Hsin determined the value of pi to 3.154 in 5 A.D., and credit for the first magic square--where a series of numbers arranged geometrically add to the same sum--is given to Lo Shu. Chu Shih-Chieh (flourished c. 1280 A.D.-1330 A.D.), a famous teacher of math, wrote two notable books. The first, a basic text, was important because it brought Chinese algebra to Japan and thus greatly influenced their math. The second, *Precious Mirror of the Four Elements* (which explained the methods for solving four linear equations containing four unknowns and numerical equations of any degree, contained a diagram for finding binomial coefficients up to the 8th power, and discussed the summation of integral finite series), placed him among the top mathematicians of all time. Chinese mathematicians also established both the concept of zero and the concept of the decimal point.

Chisho Imamura, a Japanese mathematician who flourished in the 17th century A.D. and was the first to assign a value (0.51) to the spherical volume of unit diameter, also suggested that the surface of a sphere equalled the circumference squared and divided by four. Shigeyoshi Mori (flourished c. 1600 A.D.) was the founder of the abacus calculating method in Japan and Yasauki Aida (1747-1817 A.D.) evolved Tenshei-ho algebra and founded the Mogami School of abacus calculation. Yoshida Schichibei Kuyo (1598 A.D.- ?) was the author of the oldest existing Japanese work on math, the *Jinko-ki*, which explained the operations on Soroban, including square and cube roots. Yoshisuke Matsunaza (1693-1744 A.D.) was the first Japanese to calculate pi down to 49 decimal points. Naonobu Ajima (? -1798 A.D.), one of the two most important men in Japanese math, simplified the complex calculating methods of time; formulated an original theory on the circle; developed an infinite series dealing with problems of logarithmic theory, cylindrical intersection, and the investigation of equations; and solved the problem of inscribing spheres within a larger sphere.

MEDICINE

Because acupuncture has become a household word in America, we tend to forget that Chinese medicine is--and has long been--quite similar to that of the modern West. Pien Ch'io (500 to 600 B.C.), who specialized in pediatrics and female diseases, laid the foundation of sphygmology in his book, *Nan Ching*. He also wrote, with tongue-in-cheek, a book classifying patients by their credit standing, ability to pay, and degree of hypochondria. Hwang Ti (2697-2597 B.C.), the third emperor, described the circulation of blood in this book, *Nei Ching* (The Theory of the Body's Interior). Acupuncture (as well as the moxa, in which a

small amount of incense or a plug of cloth is used to cure certain illnesses) came into use around 221 B.C. Vaccination against smallpox was accomplished by having the patient sniff powdered scabs collected from victims of the disease. Drugs, such as ephedrine (which was isolated from plants of the genus Ephedra), were used to treat lung diseases, coughs, and other respiratory illnesses.

The possibility of sex reversal was mentioned in 80 A.D. and human urine was used to treat sexual dysfunctions as early as the third century B.C. The medievalists used crystalline hormones extracted from urine (by evaporation or through the use of precipitants) for this purpose, generally separating male and female (and young and old) urine but sophisticated enough in their ideas to prepare special mixtures of the two for certain conditions. From the eighth century on, placental tissue was an important part of hormone therapy and, starting in the 13th century, testicular tissue taken from animals was used to treat some of the problems for which androgens are now prescribed.

China's early physicians were the first to add mineral drugs such as mercury and antimony to their pharmacopia and the first to recognize that diet alone could cure some diseases. (In the 14th century A.D., Hu Ssu-Hui wrote a book in which the use of diet to cure beri-beri was advocated). Another physician, Chu Hsiao (flourished 1390 A.D., died 1425), wrote an important treatise on medicine, but made his major contributions in the field of botany; describing and illustrating 414 species of plants, among them many new ones; and acclimatizing many wild plants for use in times of famine.

In 1247 A.D., Sung Tzhu wrote the first work on forensic medicine--*The Clearing of the Innocent; or The Washing Away of Wrongs* and the Japanese physician, Gempaku Sugita, opened the world of Western medicine to his people when he translated a famous Dutch medical book.

MODERN CONTRIBUTIONS

The limited number of documents translated into English and the decided lack of interest by Western historians in the science and engineering of the Far East probably explain the paucity of information available during the long period from about the first century to the 1700's. At that time, Asian names once again began to appear in scientific journals, primarily as a result of work done in cooperation with European scientists.

One of the first of these was Baron Shibusaburo Kitasato (1856-1931) who, attracted by the contributions of Robert Koch, traveled to Berlin in the mid-19th century to work under this renowned scientist. Kitasato isolated the tetanus and diptheria bacilli; discovered the bubonic plague bacillus; and with Emil Behring, another of Koch's pupils, worked out ways to treat and immunize against both diptheria and tetanus (thus opening the way for the development of antitoxin immunization).

In 1901, the new science of endocrinology was given a boost by the discoveries of Jokichi Takamine (1854-1922). The first person to isolate adrenaline

(epinephrine), he prepared four grams of this pure crystalline compound from an extract made from some 8000 bovine adrenals. He is also credited with the discovery of the starch hydrolyzing enzyme, takaminidiastase. Probably the first Japanese-American scientist of note, he arrived in the U.S. in 1890 and, before his death in 1922, used his scientific knowledge and business acumen to become a very wealthy industrialist.

Hideyo Noguchi (1876-1928), another famous American of Japanese descent, came to this country in 1900 to work for the Rockefeller Institute for Medical Research in New York. A bacteriologist, he is best known for his work with syphillis and was the first to culture the syphilitic spirochete. He is also credited with discovering the parasite responsible for yellow fever.

Yosuke Nakano (1887-1961), who came to California in 1906, obtained his master's degree from the University of California, then completed his architectural studies at the University of Pennsylvania. He became a citizen in 1952, following passage of the Walter-McCarran Act (no person of Japanese ancestry could be naturalized before that year). An expert in the use of reinforced concrete, he helped develop a now widely-used process for pumping concrete into forms in the construction of large buildings and played a part in the erection of some 200 buildings along the east coast.

Immigrants--among them the Chinese, who started arriving in the 1860's, and the Japanese, who appeared around the turn of the century--have long been welcome in America. Most of these Asian newcomers were laborers (a few, like Jokichi Takamine and Hideyo Noguchi, were well-educated and did not fit this category) who made great personal sacrifices to insure the education of their sons and daughters. Their foresight and encouragement is reflected in the scientific and engineering (fields where Asians encountered comparatively little prejudice) achievements of their offspring and in the contributions those children have made to American health, national defense, economy and education.

MEDICINE, HEALTH, AND DENTISTRY

The number of Asians in medicine and other health-related fields is quite large. Asian doctors and researchers have done more than their share to meet the challenges of the 20th century and have contributed significantly to the high esteem in which American medicine is held.

Harvey Itano, M.D., Ph.D., teaches at the UC San Diego School of Medicine. The first recipient of the Rev. Dr. Martin Luther King Medical Achievement Award (for outstanding contributions to the study of sickle cell anemia), he has also received many awards for his research in pathology.

Kazumi Kasuga, M.D., deputy chief of the U. S. Department of Health's Division of Indian Health, is a specialist in tuberculosis control. Included among his many awards is the Public Health Service's Meritorious Service Medal.

Jin H. Kinoshita, M.D., Ph.D., an ophthalmologist known for his research into sugar cataracts, is credited with finding ways to both prevent and treat this condition.

Paul I. Terasaki of the UCLA School of Medicine played a key role in the first heart transplant performed by Dr. Christian Barnard. Members of Dr. Barnard's

team studied with Dr. Terasaki for four months to learn his technique for increasing tissue compatability; a technique that lessens the chances of the transplanted heart being rejected.

Newton Uyesugi Wesley, an optometrist, played an important role in the development of contact lenses. Thanks to Wesley and his co-worker, Dr. George Jessen, the small plastic lenses used today replaced the large, uncomfortable ones previously available.

Tetsuo Akutsu, M.D., a pioneer in the development of artificial hearts, in 1973 implanted one in a calf at the University of Mississippi Medical Center. The animal survived for 24 days.

Kenneth Matsumura, M.D., of the Immunological Research Laboratory was, in 1973, granted a patent for the world's first artificial liver.

Hatsuji J. Hara, M.D., otolaryngologist and clinical professor at Loma Linda Medical School in Riverside, California developed a number of new surgical techniques.

Edward Leong Way, Ph.D., professor of Pharmacology and Toxicology and Chairman of the Department of Pharamacology and Experimental Therapeutics at the University of California, San Francisco, has won many awards (including the American Pharmaceutical Foundation Achievement Award in Pharmacodynamics) and is currently president of the American Society for Pharmacology and Experimental Therapeutics.

Chien Liu, M.D. (1921-), professor of medicine and pediatrics and director of the Division of Infectious Diseases at the University of Kansas Medical Center, and is a past president of the American Heart Association. He is known for his research into viral infections, and primary atypical pneumonia and for developing rapid diagnostic methods for influenza, measles, and respiratory viruses.

Thomas T. Noguchi, M.D., chief pathologist for the County of Los Angeles, is known to many people for his investigations into the deaths of Robert Kennedy and several Hollywood personalities. His office is internationally famous for the quality of the forensic medicine practiced there.

Terry T. Tanaka, D.D.S. (1938-). Dr. Tanaka, a Chula Vista, California dentist and dental researcher, instructor, and lecturer* specializing in gnathological (study/science of the jaw) rehabilitation and prosthodontics, was born in Los Angeles. His father came to America in 1918; his mother was born here. The family, which was relocated to Glendale, Arizona during World War II, later returned to California where they ran a truck farm in Artesia.

A foreign languages major in college, Dr. Tanaka earned his D.D.S. at the University of Southern California's School of Dentistry in 1962. He then spent two years on active duty with the U.S. Navy Dental Corps in San Diego. Besides conducting his Chula Vista practice, he is actively engaged in research (has his own lab) and has invented a variety of highly specialized instruments for use in

* for, among others, the University of Southern California's Department of Continuing Education and the University of Mexico in Mexico City and at local, county and state dental meetings.

gnathological rehabilitation, tomographic radiography, etc. Many of these, which he declined to patent, are in use at such places as the medical school in Zurich, Switzerland. A fellow and masters candidate of the Academy of General Dentistry and member of the International Academy of Gnathology, the Western Society of Periodontology, the Newport Harbor Academy of Dentistry and a number of other professional and civic organizations, he is also a faculty advisor and post doctoral thesis evaluation advisor for the National University of Mexico in Baja California and is listed in *Who's Who in the West* and *Who's Who in America*. In San Diego County and for all of Southern California, Dr. Tanaka is the primary consultant for Myo-Facial Pain Disorder and Temporo-Mandibula Joint Dysfunction Syndrome.

Others who have made significant contributions in medicine and other health related areas are: (all positions are the latest known)

Name, Place and Date of Birth	Position and Contribution
1. Jerry Kazuo Aikawa, M.D. (1921-) Stockton, California	Associate professor of Internal Medicine and Director of Lab Services, University of Colorado at Denver
2. Jeffrey Peh-I Chang, Ph.D. (1917-) China	Biologist and professor, University of Texas, Anderson Hospital and Tumor Institute, Houston. Developed techniques for staining mitochondria in frozen-dried tissues; concentrating sputum cells by millipore filtration; and staining auto-radiographs of non-diffusible isotopes. Devised open-top cyrostat for pathologic diagnosis and research.
3. Min Church Chang, Ph.D. (1908-) China	Research professor at Boston University. Conducts studies in animal reproduction, artificial insemination, mammalian fertilization, transplantation of mammalian eggs, early embryonic development, and oral contraceptives.
4. Jowett Chao, Ph.D. (1915-) China	Research Zoologist at UCLA. Conducts research into host-parasite-vector relationship in vitro culture of malaria and other blood parasites; studies the biology and internal microorganisms of mosquitos.
5. Ko Kuei Chen, Ph.D. (1898-) China	Past director of pharmacological research for Eli Lilly and Company and professor at Indiana University. Known for research in ephedrine, new synthetic analgesics, vasoconstrictors, digitalis. Developed an antidote for cyanide poison.
6. Shu Chien, Ph.D. (1931-) China	Associate professor at Columbia University in New York City. Analyzes the factors concerned with regulation of blood volume and viscosity; evaluates the roles played by the sympathetic

		nervous system and endocrine systems in compensatory responses to hemorrhage; and studies circulatory disturbances in shock due to hemorrhage.
7.	Shelley Nien-chun Chou, M.D., Ph.D. (1924-)	Associate professor of Neurosurgery at the University of Minnesota. Research into intracrania lesions, malformations of cerebral vasculator and neurological dysfunctions of the bladder.
8.	Kao Liang Chow, Ph.D. (1918-) China	Professor of neuropsychology at Stanford Medical School. Known for establishing the connections from the thalamus to the cortex. Studies the effects of light deprivation on new born animals and the neural basis of learning and memory.
9.	Roy H. Doi, Ph.D.	Bacteriologist at the University of California, Davis.
10.	Jacob Fong, Ph.D. (1913-1967) China	Professor of bacteriology at UC Berkeley. Research in infectious diseases, cellular immunity, bacteriophage, the replication of myxoviruses, and mammalian cell cultures.
11.	James Masao Fujomoto, Ph.D. (1928-) Vacaville, California	Professor of pharmacology at Tulane Medical School in New Orleans. Researches metabolism drugs and narcotic drugs.
12.	Paul T. Fukui, M.D.	Neurologist at the Veterans Hospital in Coatesville, Pennsylvania.
13.	Teruo Hayashi, M.D.	Professor of obstetrics and gynecology at the University of Pittsburg in Pennsylvania.
14.	Norio Higano, M.D.	Professor of internal medicine at the University of Massachusetts.
15.	Teruo Hirose, M.D., Ph.D. (1926-) Japan	Thoracic surgeon in the Bronx, New York. Research into the single-pass, low prime, heart-lung machine; the low cardiac pressure suction machine; and into the reconstruction of the aortic valve with autologous tissue.
16.	David Yi-Yung Hsia, M.D. (1925-) China	Pediatrician in Chicago, Illinois, and director of the Research and Genetics Clinic at Childrens Memorial Hospital. Researches human biochemistry and genetics.
17.	Funan Hu, M.D. (female) (1919-) China	Dermatologist with the Oregon Regional Primate Research Center and Professor of Dermatology at the Medical School of the University of Oregon in Portland. Research into cytology and pigmentary disorders.

18.	Kimishige Ishizaka, M.D.	Immunologist and professor at the John Hopkins Medical School in Maryland.
19.	Frederick Fengtien Kao, M.D., Ph.D. (1919-)	Professor of physiology at State University of New York in Brooklyn. Research into the nervous and chemical control of breathing and the heart rate, and the effects of anesthesia on the heart and respiration.
20.	Riojun Kinoshita, M.D.	Pathology director at City of Hope Medical Center in Duarte, California.
21.	S. S. Kurahara, M.D., Ph.D.	Radiologist and assistant professor at the University of Southern California.
22.	Cheng-Chun Lee, Ph.D. (1922-) China	Head of the pharmacology and toxicology department of Midwest Research Institute in Kansas City, Missouri, and assistant professor at the University of Kansas Medical Center. Research into drug absorption, distribution, excretion, and metabolism; antimicrobial agents; cholic acid; and cholesterol metabolism.
23.	Joseph Ching-Yuen Lee, Ph.D., M.D. (1922-) China	Neuroanatomist and experimental neuropathologist. Associate professor of anatomy at State University of New York, Buffalo. Research into vascular permeability of the brain; ultrastructural changes in nerves and muscles; cerebral edema and brain tumors.
24.	Chen Pien Li, M.D. (1898-) China	Chief, Virus Biology Division, Biological Standards, National Institute of Health, Bethesda, Maryland. Devised method for cultivation of vaccine virus; isolated an avirulent strain of type 1 polio virus that is now used in the Sabin polio vaccine; discovered antiviral and anti-bacterial paolins from abalone, oysters, clams, and calf thymus.
25.	Choh-Lu Li, M.D., Ph.D. (1919-) China	Associate neurosurgeon, National Institute of Health, Bethesda. First to use microelectrodes in the study of electrical activity of single nerve cells in the cerebrum. Researches brain wave activity and discharge relationships, and Parkinsonism.
26.	Chi Kong Liu, M.D. (1920-) China	Associate professor of Medicine, UCLA and chief of the cardiac catherization lab at Mt. Sinai Hospital. Discovered a method to record heart sounds and murmurs in four chambers of the heart and to measure blood volume in arterial and venous segments of the lungs.

27.	Tom Saburo Miya, Ph.D. (1923-) Hanford, California	Head, department of pharmacology, Purdue University, Lafayette, Indiana. Research into tranquilizers, tolerance development, and the detoxication mechanism and the effect of endocrines in drug action.
28.	Yosh Murayama, M.D.	Radiologist at the University of Kansas.
29.	George Nagamatsu, M.D.	Urologist and surgeon, New York, New York.
30.	Shih Hsun Ngai, M.D. (1920-) China	Professor of Anesthesiology, Columbia University College of Physicians and Surgeons, and attending anesthesiologist, Presbyterian Hospital of New York City. Author of many books on anesthesiology.
31.	Edwin Takayasu Nishimura, M.D. (1918-) Sacramento, California	Professor and chairman of the department, University of Hawaii School of Medicine. Research in cell physiology of cancer cells, enzyme abnormalities, enzymes and immunity.
32.	Joseph H. Ogura, M.D. (1915-) San Francisco, California	Professor and head, Department of Otolaryngology, Washington University, St. Louis, Missouri. Research in disorders of larynx and nose; the mechanisms of swallowing, and larynx transplantation.
33.	George Toras Okite, Ph.D. (1922-) Seattle, Washington	Professor of pharmacology, Northwestern University Medical School, Chicago, Illinois. Research in digitalis heart drugs; the metabolism of digitalis in patients; the biochemistry of carcinogenesis and metabolic disorders.
34.	Patrick Okura, M.D.	Director of the Nebraska Psychiatric Institute.
35.	Minol Ota, D.V.M.	Veterinarian, Lovell, Wyoming.
36.	Kinichi Shibutani, M.D.	Anesthesiologist, Grasslands Hospital, Valhalla, New York.
37.	Donald Shima, D.D.S.	Instructor in dental surgery, Fairleigh Dickinson University.
38.	Hiromi Shinya, M.D.	Chief of surgical endoscopy unit, Beth Israel Medical Center, New York and assistant professor of surgery, Mount Sinai School of Medicine, New York.
39.	Akira Shirai, Ph.D.	Microbiologist, industrial biological laboratory research at Walter Reed Army Hospital, Maryland.
40.	Hiroshi Sugiyama, Ph.D.	Bacteriologist, professor at University of Wisconsin.

41.	Er Yi Ting, M.D. (1919-) China	Assistant professor of medicine, New York Medical College, New York City, and director, Pulmonary Function Research Lab, Metropolitan Hospital Center. Research in respiratory physiology.
42.	George K. Tokuhata, Ph.D.	Director of research, Pennsylvania Department of Health.
43.	Henry M. Tsuchiya, Ph.D.	Microbiologist and professor at the University of Minnesota.
44.	Ging Hsi Wang, Ph.D. (1897-) China	Research associate, Laboratory of Neurophysiology, University of Wisconsin, Madison. Research into the four-day activity cycles in female rats and their relation to ovarian secretion.
45.	Harry Hsi Wang, M.D. (1907-) China	Embryologist and professor of anatomy, Loyola University Stritch School of Medicine, Chicago, Illinois. Research in developmental biology, feather regeneration, quality of meat and cigarette toxicities.
46.	Shih Chun Wang, M.D., Ph.D. (1910-) China	Physiologist and professor of pharmacology, Columbia University College of Physicians and Surgeons. Research in physiology and pharmacology of the automatic nervous system.
47.	Yang Wang, M.D. (1923-) China	Director, Cardiac Catherization Lab, University of Minnesota, Minneapolis. Research in cardiovascular physiology.
48.	Harry Yuen Chee Wong, Ph.D. (1917-) Hawaii	Physiologist, endocrinologist, and professor at Howard University College of Medicine in Washington, D.C. Research in atherosclerosis and endocrinology.
49.	Ts'ai Fan Yu, M.D. (1911-) China	Associate professor, department of medicine, Mt. Sinai School of Medicine, New York City. Research in the pathogenesis of gout and uric acid metabolism.

PHYSICS

Among the numerous persons of Asian ancestry who have distinguished themselves in the world of physics are five recipients of the Nobel Prize.

In 1949, Hideki Yukawa became the first Asian to receive the Nobel Prize. He hypothesized the existence of mesons in 1935 and proved this experimentally by 1949. A professor at the Institute for Advanced Study and Columbia University from 1948 to 1953, Yukawa is now director of Research Institute for Fundamental Physics at Kyoto University. (Two other famed physicists--S. Sahata and Y. Tanikawa--are credited with hypothesizing the existence of two kinds--muons and pions--of mesons.)

Chen Ning Yang and Tsung Dao Lee shared the Nobel Prize honors in 1957 for their prediction that the law of conservation of parity does not work in the case of weak interactions. This discovery led to an extensive revision of basic theory in atomic physics. Both Yang, a professor at the Institute for Advanced Study at Princeton, and Lee, a professor at Columbia University, received their Ph.D.s from the University of Chicago. Interesting biographical accounts of these two famous physicists can be found in the March, 1960 issue of *Fortune Magazine* (see bibliography).

Shinichiro Tomonaga received the Nobel Prize in 1965 for his investigation into the inconsistencies in the prediction of quantum electrodynamics. His research was accomplished during World War II and it was not until after the war that his work came to the attention of Western scientists. He is also noted for his work on the theory of neutrons and, in collaboration with another noted Japanese physicist, Masao Kotani, his work in electromagnetics.

Leo Esaki accomplished his research into the ultra-fast, ultra-small tunnel (Esaki) diode (on which the entire communication, computer, and electronic equipment industry is dependent) while a member of a small research group at the Sony Corporation in Tokyo. The theoretical aspects of this discovery won him the Nobel Prize in 1973. Now a resident of New York, he works on semimetals and tunneling for IBM at its T. J. Watson Research Center in Yorkstown.

Yusuke Hagihara, another giant in the world of astrophysics, proved that the stability of planets is influenced by the gravitational attraction of the sun and other satellites in the system; contributed to the theory of planetary nebulae; developed a theory of astronomical refraction; worked on a relativistic explanation of the theory of aberration; and studied the effects of photographic halation and sky scattering in coronal photography.

Chien-Shiung Wu, a very prominent experimental physicist, confirmed much of Yang and Lee's works on the non-parity theory. With them, she reported experimental confirmation of a new fundamental theory in nuclear physics--the theory of conservation of vector current in nuclear beta decay. Currently on the physics faculty of Columbia University, she experimentally established non-conservation of parity in beta decay and, during World War II, was an important member of the Manhattan Project team which was responsible for the development of the first nuclear bomb. A graduate of National Central University of China and UC Berkeley, Dr. Wu also conducts studies in sickle cell anemia and the possible existence of double beta decay.

Others who have made significant contributions in physics are:

Name, Place and Date of Birth	Position and Contributions
1. Syun-Ichi Akasofu, Ph.D. (1930-) Japan	Professor of geophysics, University of Alaska. Studies on the Aurora Polaris.
2. Edward Takashi Arakawa, Ph.D. (1929-) Honolulu, Hawaii	Physicist, Oak Ridge National Laboratory. Research on radioisotope treatment of cancer patients, radiation dosimetry of Japanese A-bomb survivors. Discovered plasma radiation in aluminum. Developed polarizers for vacuum ultraviolet radiation.

3.	Di Chen, Ph.D. (1929-) China	Senior principal research scientist, Honeywell Corporation Research Center, Hopkins, Minnesota. Research in emitting-sole magnetron amplifier, magneto-optic and magnetic properties of thin films of manganese bismuth. Invented absorption-type laser modulator.
4.	Francis F. Chen, Ph.D. (1929-) China	Research physicist, plasma physics lab, Princeton University. Research on theory and experiments relating to instabilities of a plasma in a magnetic field and escape of plasma from magnetic bottles. Developed method of Langmuir probes for plasma measurements.
5.	Ping-Yao Cheng, Ph.D. (1921-) China	Biophysicist, Lawrence Radiation Lab, Livermore, California. Researches sedimentation velocity; viscosity, diffusion, and optical rotatory dispersion; and the size, structure, and functions of viruses, enzymes, and nucleic acids.
6.	Peter Fong, Ph.D. (1924-) China	Professor of physics, Emory University, Atlanta, Georgia. Author of statistical theory of nuclear fission, explaining fission phenomena from the first principles. Contributed to the theory of origin of chemical elements in astrophysics. Author of new formulation of thermodynamics as macroscopic theory of equilibrium and of the statistical theory of biological functions of nucleic acids (DNA and RNA) and of origin and evolution of life.
7.	Shigeji Fujita, Ph.D. (1929-) Japan	Associate professor of physics, State University of New York, Buffalo. Research in kinetic theory of gases and plasmas, solid state theory, and polymer physics. Developed statistical mechanics theory which treats transport and optical properties of matter on a rigorous basis.
8.	Su-Shu Huang, Ph.D. (1915-) China	Professor of astrophysics, Northwestern University, Chicago. Research in atomic physics and astrophysics, especially stellar atmosphere, stellar spectroscopy, binary stars, and bioastronomy.
9.	Mitio Inokuti, Ph.D. (1935-) Japan	Physicist, Argonne National Lab, Illinois. Research on effects of ionizing radiation of molecular substances as basis for fundamental radiation physics.
10.	Walter Kato, Ph.D.	Chief of reactor physics, Argonne National Laboratories, Illinois.

11.	Chichiro Kikuchi, Ph.D. (1914-) Seattle, Washington	Head, Solid State Physics Lab, University of Michigan, Ann Arbor. Research in ruby lasers, electron spin resonance, quantum electronics, and radiation effects in solids.
12.	Toichiro Kinoshita, Ph.D. (1925-) Japan	Professor of physics, Columbia University, New York. Research in structure of elementary particles and their mutual interactions.
13.	Shu-Hua Li, D.Sc. (1890-) China	Physicist, New York City. Research in electric osmosis and physical properties of large molecules.
14.	Shao-Chi Lin, Ph.D. (1925-) China	Professor of engineering physics, University of California, San Diego. Research in re-entry physics, electrical and electromagnetic properties of ionized gases, and shock wave phenomenon.
15.	Sadami Matsushita, Dr.Sc. (1920-) Japan	Professor of physics, University of Colorado, Boulder. Discovered lunar effects on lower ionosphere and the special ionospheric zone of sporadic E over magnetic equator.
16.	Robert Naka, D.Sc.	Specialist in electron optics. Deputy Undersecretary of the Department of the Air Force.
17.	Yoshinari Nakagawa, Ph.D. (1923-) Tacoma, Washington	Senior scientist, High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado. Research in geophysics, astrophysics. Pioneered hydromagnetic experiments.
18.	Susumu Okubo, Ph.D. (1930-) Japan	Professor of physics, University of Rochester, New York. Research into symmetry properties in weak interactions and strong interactions of elementary particles.
19.	Carl Tatsuo Tomizuka, Ph.D. (1923-) Japan	Professor of physics, University of Arizona, Tucson. Research in atom movement in solids, the nature of vacant site created within solids. Developed reliable method to study atom movement in solids at high pressures and temperatures.
20.	Simpei Tutihasi, D.Sc.	Physicist, Xerox Corporation, New York.
21.	Kiyo Tomiyasu, Ph.D.	Director of General Electric's Laser Laboratory, Schenectady, New York. An authority on radio microwaves; holds many patents in this area.
22.	Hiroomi Umezawa, D.Sc. (1924-) Japan	Professor of physics, University of Wisconsin, Milwaukee. Research in quantum field theory, quantum mechanics, high energy particle physics, and the theory of many-body physics.

23.	Kenichi Watanabe, Ph.D. (1910-) Honolulu, Hawaii	Senior professor of physics, University of Hawaii. Research in spectroscopy and atmospheric physics, extreme ultraviolet absorption and ionization of molecules, and their applications to upper atmospheres.
24.	Ta-You Wu, Ph.D. (1907-) China	Professor of physics, State University of New York, Buffalo. Research in the fields of atomic, molecular, and nuclear physics, scattering theory, and kinetic theory plasmas.
25.	Tai Tsun Wu, Ph.D. (1933-) China	Professor of physics, Harvard University, Cambridge, Massachusetts. Research in statistical mechanics, electromagnetic theory, and elementary particles.
26.	Sukeyasu Steven Yamamoto, Ph.D. (1931-) Japan	Associate professor of physics, University of Massachusetts, Amherst. Research in high energy physics using bubble chambers to study nature of fundamental particles. Took part in discovery of omega minus particle.
27.	Luke Chia-Liu Yuan, Ph.D. (1912-) China	Senior physicist, Brookhaven National Lab, Upton, New York. Established existence of first pion-nucleon resonance in high energy interactions. Research in proton-antiproton interactions and pion-proton and proton-proton interactions at very high energies.

CHEMISTRY

Another field in which scientists of Asian descent have become prominent is chemistry.

Ju Chin Chu, Ph.D., technical advisor, autonetics, for North American Rockwell Corporation in Anaheim and former professor of chemical engineering, Polytechnic Institute of Brooklyn. Chu is one of the world's leading authorities on petrochemical processing and propulsion; holds many patents in this area and serves as a consultant to a number of companies.

Choh Hao Li, Ph.D., (1913-) biochemist, endocrinologist, and director of the Hormone Research Laboratory at the University of California at San Francisco, is known for his work on the pituitary gland. He determined the composition and structure of both ACTH (adrenocortico-tropic hormone) and HGH (human growth hormone) and has isolated and identified five hormones of the anterior pituitary gland.

Shigeo Wakamatsu, Ph.D., an organic chemist employed by Lever Brothers of New York, has seen many of his research findings applied to the development of household consumer goods.

Others who have contributed are:

Name, Place and Date of Birth	Position and Contributions
1. Minoru Amemiya, Ph.D.	Soil chemist and researcher, Iowa State University
2. Chia Chung Cheng, Ph.D. (1925-) China	Head, Medical Chemistry Section, Midwest Research Institute, Kansas City, Missouri. Research in the synthesis and evaluation of antibiotics, antimetabolites, alkylating agents, vitamin analogs, anticancer and antimalarial compounds.
3. Ying Nan Chiu, Ph.D. (1933-) China	Associate professor of chemistry, Catholic University of America. Research in the application of angular momentum and irreducible tensor methods in molecular quantum mechanics and molecular spectroscopy; the expansion of irregular solid spherical harmonics; and the theory of higher multipole radiation in molecules.
4. Ting Li Chu, Ph.D. (1924-) China	Chemist and professor of electrical engineering and electronic sciences, Southern Methodist University, Dallas, Texas. Research in preparation techniques for crystals and thin films of electronic material, crystal growth process, and defect formation.
5. Henry N. Fukui, Ph.D.	Professor of chemistry, Youngstown (Ohio) College.
6. Tetsuo Roy Fukuto, Ph.D. (1923-) Los Angeles, California	Chemist, Stauffer Chemical Company, Riverside, California. Research in the mode of action of organophosphorus esters; the mode of action, metabolism, and structure activity relations in insecticides.
7. Ryoichi Hayatsu, Ph.D.	Organic chemist and research assistant at the University of Chicago, Illinois.
8. Takeru Higuchi, Ph.D. (1918-)	Professor of pharmacological chemistry, University of Kansas, Lawrence. Developed applications of physical chemistry principles to the pharmacology system.
9. Konrad Chang Hsu, Ph.D. (1901-) China	Chemist and associate professor of microbiology at Columbia University, New York City. Research in immunochemistry and the pathogenesis of streptococcal disease.
10. Miyoshi Ikawa, Ph.D.	Professor of biochemistry, University of New Hampshire.

11.	Susumu Ito, Ph.D.	Assistant professor of chemistry, Harvard Medical School.
12.	Paul K. Kuroda, Ph.D.	Professor of chemistry, University of Arkansas, Fayetteville.
13.	Lieng-Huang Lee, Ph.D. (1924-) China	Senior research chemist, Dow Chemical Company, Midland, Michigan. Discovered the wettability and glass temperature relationship for polymers and invented a new method for rain stimulation and new polymers and monomers.
14.	Norman Chung Li, Ph.D. (1913-) China	Professor of chemistry, Duquesne University, Pittsburg, Pennsylvania. Research into the nature of metal binding and hydrogen bonding in biological systems.
15.	Tsu Sheng Ma, Ph.D. (1911-) China	Professor of chemistry, City University of New York. Research in microchemistry, organic chemistry, synthetic drugs. Developer of chemistry teaching methods using simple equipment.
16.	William Tsunehisa Murakami, Ph.D.	Biochemist, Brandeis University, Massachusetts.
17.	Jack Murata, Ph.D.	Agricultural Chemist, Department of the Interior, Washington, D.C.
18.	Yoshiharu Okaya, Ph.D. (1927-) Japan	Professor of chemistry, State University of New York, Stony Brook. Research in crystal and molecular structure determination with X-ray and neutron diffraction techniques. Established steric configuration of aureomycin.
19.	George T. Okita, Ph.D.	Professor of pharmacology, Northwestern University, Evanston, Illinois.
20.	Peter Pen Tieh Sah, Ph.D. (1900-) China	Bio-organic chemist and professor of comparative pharmacology, UC Davis. Research in micro reagents, synthesis of vitamin C from carbohydrates. Discoverer of Vitamin K; new drugs for lung diseases; IHHG for human tuberculosis; Vitamin C derivative of sulfone for leprosy; and new antihypertensives and antivirus agents.
21.	Warick Sakami, Ph.D. (1916-) Philadelphia, Pennsylvania	Professor of biochemistry, Western Reserve University School of Medicine, Cleveland, Ohio. Research in the metabolism of amino acids and one-carbon compounds and in the metabolic functions of folic acids.
22.	George Yukio Shinowara, Ph.D. (1914-) Seattle, Washington	Director of biochemistry, Bellevue Hospital and professor, Department of Pathology, New York University School of Medicine. Isolated antithrombin from plasma; antihemophilic globulin and lipoprotein from erythrocytes.

23.	Noboru Sueoki, Ph.D.	Assistant professor of biochemistry, Princeton, University.
24.	James Masanobu Sugihara, Ph.D. (1918-) Las Animas, Colorado	Professor of chemistry, North Dakota State University, Fargo. Consultant, Sun Oil Co. Research in carbohydrate chemistry and metal compounds in crude oils.
25.	Thomas T. Sugihara, Ph.D. (1924-) Las Animas, Colorado	Professor of chemistry, Texas A & M University. Research in nuclear fission process, oceanic circulation studies by means of radioactive tracers. (Brother of James Sugihara).
26.	Kanematsu Sugiura, D.Sc. (1892-) Japan	Chemist and member emeritus, Sloan-Kettering Institute of Cancer Research, Rye, New York. Research in cancer, etiology, immunity, radiation and drug treatment, nutrition, and animal tumor storage for transplantation.
27.	A. E. Takemori, Ph.D.	Pharmacologist at the University of Minnesota.
28.	Mitsunoba Tatsumoto, D.Sc. (1923-) Japan	Geochemist, U.S. Geological Survey, Denver, Colorado. Research into using lead isotopes as tracers, source rocks, generation of magma and effects of crustal contamination and minor element distribution in deep sea deposits.
29.	Shiro Tashiro, Ph.D. (1883-) Japan	Was professor of biochemistry at the University of Cincinnati, Ohio. Invented biometer to measure carbon dioxide given off by small amounts of tissue.
30.	Tche Tsing Tchen, Ph.D. (1924-) China	Professor of biochemistry, Wayne State University, Detroit, Michigan. Research in enzymatic reactions, sterol biogenesis and metabolism, and the control of genetic expression.
31.	Roy Teranishi, Ph.D. (1922-) Stockton, California	Research chemist, U.S. Department of Agriculture, Albany, California. Research in gas chromatographic techniques in the study of aroma chemistry.
32.	Lee Karl Jan Tong, Ph.D. (1913-) China	Senior research associate, Eastman Kodak, Rochester, New York. Research in reaction kinetics, polymerization reactions, and the mechanics of dye formation in color photography.
33.	Yulan C. Tong	Pharmaceutical researcher, Dow Chemical, Walnut Creek, California
34.	Tien Chioh Tso, Ph.D. (1917-) China	Principal plant physiologist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland. Research into tobacco plants and health-related factors. Established and eliminated the source of radio-elements in tobacco.

35. Kwan Chung Tsou, Ph.D. (1922-) China — Associate professor of chemistry, University of Pennsylvania School of Medicine, Philadelphia. Research in cancer chemotherapy, organic synthesis, enzyme histochemistry, and polymer chemistry.

36. Minoru Tsutsui, D.Sc. (1918-) Japan — Professor of organic chemistry, New York University, New York City. Discovered a new chemical bond; involved in research in organo-transition metal chemistry and arene metal pi-complexes.

37. Chi Che Wang, Ph.D. (1894-) China — Retired biochemist. Research in chemistry of biological fluids, food products, mineral and protein metabolism of the obese and undernourished.

38. Chih Hsing Wang, Ph.D. (1917-) China — Professor of chemistry, director of Radiation Center and director, Institute of Nuclear Science and Engineering, Oregon State University, Corvallis. Developed radio tracer methodology in biochemical research.

39. Jui Hsin Wang, Ph.D. (1921-) China — Professor of chemistry and biochemistry, Yale University, New Haven, Connecticut. Elucidated relationship between molecular structure and biological function. Research in diffusion in liquids and reaction mechanisms.

40. Shih Yi Wang, Ph.D. (1923-) China — Professor of biochemistry, John Hopkins University, Baltimore, Maryland. Proposed molecular aggregation and puddle formation hypothesis for frozen solutions and provided insight into the understanding of photochemistry of nucleic acids.

41. Yasuo Yagi, D.Sc. (1921-) Japan — Professor of chemistry, State University of New York, Buffalo. Research in antibodies, antigenic determinant regions in protein antigens and immunochemistry.

42. Kerry Tsuyoshi Yasunobu, Ph.D. (1925-) Seattle, Washington — Professor of biochemistry, University of Hawaii. Research in enzyme and protein chemistry.

43. Teh Fu Yen, Ph.D. (1927-) China — Chemist and senior fellow, Mellon Institute, Pittsburg, Pennsylvania. Research in the structural evaluation of complex molecules and polynuclear aromatic hydrocarbons.

SPACE SCIENCE

With the advent of the missile program in the 1960's, many Asian-American scientists applied their talents to various space science and national defense programs.

Thomas T. Yamauchi, Chief of Systems Engineering and Technology on the Lunar Orbiter Program and Viking Program Engineer for the Boeing Company of Seattle; helped with the technical aspects of putting the first man on the moon.

Thomas T. Omori, Ph.D., an aerospace scientist, is Far East manager for International Operations, Aerojet General Corporation (Azusa, California) and an authority on high energy propellants, lunar probes, ballistic missiles, and nuclear energy.

Other space scientists who have contributed to our space program and our national defense are:

Name, Place and Date of Birth	Position and Contributions
1. Toshi Kubota, Ph.D.	Associate professor of aeronautical engineering, California Institute of Technology.
2. Syukuro Manabe, D.Sc.	Meteorologist, Environmental Science Service, Washington, D.C.
3. Minoru P. Nakada, Ph.D. (1921-) Los Angeles, California	Physicist, Goddard Space Flight Center, Greenbelt, Maryland. Research into V-particles by study of decay products and measuring lifetimes, diffusion theory of the formation of the outer radiation belt.
4. Katsuyaki Ooyama, Ph.D.	Meteorologist, New York City.
5. Kuo Tai Yen, Ph.D. (1919-) China	Fluid physicist and principal scientist, Space Science Lab, Missile and Space Division, General Electric Company, Philadelphia, Pennsylvania. Research in electro magnetic wave propagation, plasma physics, magneto-gas dynamics, and solar physics.
6. Ronald Y. Yoshida	Mechanical engineer, Jet Propulsion Lab, Pasadena, California.
7. Phil Yip	Thermodynamicist, Convair, San Diego.

In their *Minority Profiles* (see Bibliography), NASA lists the following Asian-Americans among their employees:

Name and Place of Birth	Education and Awards	Position and Contributions
1. Shizuo Doiguchi California	B.S., mechanical engineering UC Berkeley M.S., engineering mechanics Stanford University	Assistant chief Research Facilities and Instrumentation Division Ames Research Center
2. Al C. Fang (female) China	B.S., physics Sun Yat-Sen University M.S., mathematics George Washington University	Program engineer Data Management Program Office Headquarters

3.	Louis B. C. Fong Boston, Massachusetts	B.S., electrical engineering M.I.T. M.S., engineering administration, George Washington University; Executive Fellowship, Brookings Institute	Intergovernmental affairs officer Office of Applications Headquarters
4.	Josephine Jue	B.S., mathematics University of Houston	Mathematician Johnson Space Center
5.	Paul Pao, Ph.D. China	Graduate of National Taiwan University M.S. and Ph.D., University of Florida	Aero-space technologist Langley Research Center; Internationally known for contributions in supersonic jet noise research
6.	Henry P. Wong	B.S. and M.S., mechanical engineering, University of California; registered professional engineer; Apollo and Skylab achievement awards	Aerospace engineer Spacelab Program Headquarters
7.	Robert Y. Wong	B.S. and M.S., mechanical engineering, University of Minnesota	Head Small Turbomachinery Section, Lewis Research Center
8.	Suey T. Yee China	B.S. and M.S., civil engineering, Ohio State University	Head Structural Design Section Facilities Engineering Division, Lewis Research Center

MATHEMATICS

Shiing-Shen Chern, D.Sc. is well known in the field of mathematics for his contribution to differential geometry in the large. His most noteworthy contribution is the Chern character (which has applications to topology). Other areas in which Chern worked include the decomposition theorem on harmonic forms of Kahlerian G. structures, total curvature of closed submanifolds in Euclidean space, and uniqueness theorems on submanifolds satisfying geometrical domain. He is currently a member of the mathematics faculty of the University of California at Berkeley.

Other mathematicians of note are:

Name, Place and Date of Birth	Position and Contributions
1. Chen Chung Chang, Ph.D. (1927-) China	Professor of mathematics, UCLA Consultant to industry. Fulbright research scholar, Oxford, 1966-67. Studies of abstract algebra, set theory, and logic.

2.	Yu Why Chen (1910-) China	Professor of math, Wayne State University, Detroit, Michigan. Research into the theory and applications of partial equations.
3.	Shoshichi Kobayashi, Ph.D. (1932-) Japan	Professor of mathematics, UC Berkeley. Global studies of manifolds with differential geometric method.
4.	Junichi Igusa, Ph.D.	Professor of mathematics, John Hopkins University, Baltimore, Maryland.
5.	Kinkichi Iwasawa, D.Sc.	Professor of mathematics, M.I.T. and Princeton University.
6.	Tomio Kubota, D.Sc.	Professor of mathematics, University of Maryland.
7.	Chia-Chiao Lin, Ph.D. (1916-) China	Professor of mathematics, M.I.T. Research in stellar dynamics, hydrodynamics, astrophysical problems.
8.	Teruhisa Matsusaka, D.Sc. (1926-) Japan	Professor of mathematics, Brandeis University, Waltham, Massachusetts. Research into geometric objects defined as set of common zeros of a finite set of polynomials.
9.	Lu Ting, Sc.D. (1925-) China	Aerodynamicist and professor of mathematics, New York University. Research into blast waves, supersonic wing-body interference, viscous mixing problems, space trajectories, and optimum techniques.
10.	Hsien Chung Wang, Ph.D. (1919-) China	Professor of mathematics, Cornell University, Ithaca, New York. Research into the theory of lie groups, differential geometry, and totally discontinuous groups.
11.	Chung-Tao Yang, Ph.D. (1923-) China	Professor of mathematics, University of Pennsylvania, Philadelphia.

ENGINEERING

When our country experienced a critical shortage of engineers, thousands of Asians helped fill the gap. Among the most outstanding are:

David H. Furukawa, a research engineer for the U.S. Bureau of Reclamation in Denver, Colorado, who is known for his work on desalinization of brackish water.

Chihiro Kikuchi, Ph.D., atomic engineer, physicist, and mathematician currently on the faculty of the University of Michigan, who showed that synthetic rubies are an ideal material for use in masers.

Others who have contributed are:

Name, Place and Date of Birth	Position and Contributions
1. Sin-I Cheng, Ph.D. (1921-) China	Professor of aeronautical engineering, Princeton University. Research in gas dynamics and propulsion sciences; nature and origin of sudden failure in rocket motors in operation, and probable remedies.
2. David K. Cheng, Sc.D. (1918-) China	Engineer and research project director, Syracuse University Research Institute. Investigation of Z-transform theory of antenna arrays; phase-error effects in microwave reflectors; signal processing array synthesis; gain and signal-to-noise ratio optimization techniques; electromagnetic problems in plasma environments; diffraction field measurements with light-modulated scattering techniques.
3. Ju-Chin Chu, Sc.D. (1919-) China	Chemical engineer and technical adviser, Autonetics, North American Rockwell, Anaheim, California. Research in propulsion; energy conversion fuel cells; distillation; nuclear technology; kinetics; and thermodynamics.
4. Ven Te Chow, Ph.D. (1919-) China	Professor of hydraulic engineering, University of Illinois, Urbana. Developed stochastic methods for hydrologic analysis and design and engineering planning for drainage, flood control, and other water resources projects. Developed the science of watershed hydraulics.
5. Hatsuaki Fukui, D.Eng.	Engineer and vice-president of Sony Corporation of America.
6. Thomas K. Ishii, Ph.D.	Professor of electrical engineering, Marquette University.
7. Seichi Konzo, Ph.D.	Professor of mechanical engineering, University of Illinois.
8. Tung Yen Lin, M.S. (1911-)	Structural engineering consultant, San Francisco. Design of steel and prestressed concrete structures; bridge and structural engineering.
9. Henry T. Nagamatsu, Ph.D.	Research and development engineer, General Electric Co.
10. Richard Hsien Feng Pao, Ph.D. (1926-) China	Professor and chairman of the civil engineering department, Rose Polytechnic Institute, Terre Haute, Indiana. Studies in incompressible fluid mechanics and the statistical analysis of hydrological data.

11.	Chi-Neng Shen, Ph.D. (1917-) China	Professor of mechanical engineering, Rensselaer Polytechnic Institute, Troy, New York. Research in non-linear and optimum systems; synthesis and compensation; process dynamics; nuclear rocket control and astrodynamical guidance.
12.	Henry Mitsumasa Tsuchiya, Ph.D. (1916-) Seattle, Washington	Professor of bio-engineering, University of Minnesota, Minneapolis. Research in the dynamics of microbial populations; enzymatic polymerization and depolymerization of polysaccharides; chemotherapy and the disposal of industrial wastes.
13.	Otto Arthur Uyehara, Ph.D. (1916-) Hanford, California	Professor of mechanical engineering, University of Wisconsin, Madison. Research in flame temperature measurements in both diesel and spark ignition engines as a function of time. Studies of the internal combustion engine and auto exhaust emission.
14.	Kung Chie Yeh, Ph.D. (1930-) China	Associate professor of electrical engineering, University of Illinois, Urbana. Studies in ionospheric propagation problems and ionospheric propagation problems and ionospheric physics.

OTHERS

Asian-Americans who have come to prominence in other scientific disciplines include:

Name, Place and Date of Birth		Position and Contributions
1.	Thomas Clement Cheng, Ph.D. (1930-) China	Associate professor of zoology, University of Hawaii. Research in the development of parasitic flatworms; the physiology of animal parasites; defense mechanisms of mollusks; experimental invertebrate pathology; and the interrelationships among invertebrate animals.
2.	Te May Tsou Ching, Ph.D. (female) (1920-) China	Associate professor, Oregon State University, Corvallis. Research into safe storage conditions for foreign seeds; freeze-drying coniferous pollen for preservation; biology of seed development and germination; lipid metabolism in coniferous seeds.
3.	Sidney Chihti Hsiao, Ph.D. (1905-) China	Professor of zoology, University of Hawaii, Research into the radiocalcium uptake in sea urchins and the effect of ionizing radiation in the early development of sea urchins.

4. Hiroyuki Hirumi, M.D. (1932-) Japan — Biologist and research associate, Boyce Thompson Institute, Yonkers, New York. Cultivation of leafhopper-borne virus vector tissues and nematode tissues in vitro.

5. Wan Cheng Chiu, Ph.D. (1919-) China — Professor of meteorology, University of Hawaii. Research in atmospheric tides; large scale atmospheric wind systems; energies associated with various scales of atmospheric motions.

6. Francis Lang-Kwang Hsu, Ph.D. (1911-) China — Anthropologist and chairman of the department, Northwestern University, Evanston, Illinois. Studies patterns of culture and personality of Chinese, Hindus, Japanese, and white Americans.

7. Chiuh Tao Hsu, Ph.D. (1917-) China — Professor of biology, University of Texas; M.D. Anderson Hospital and Tumor Institute, Houston. Research in chromosomes and their role in evolution.

8. Hsi Fan Hsu, D.Sc. (1906-) — Research professor of preventive medicine and environmental health, University of Iowa, Iowa City. Research into, and successful immunization of Rhesus monkeys against schistosoma japonicum.

9. Shu Ying Hsu, Ph.D. (1920-) China — Research associate and professor of preventive medicine and environmental health, University of Iowa, Iowa City. Engaged in the same work as his wife (entry #8).

10. Hsing Tsung Huang, D.Phil. (1921-) Malaya — Director, biological sciences, Research and Development Division, International Mineral and Chemical Corp., Libertyville, Illinois. Research in organic chemistry, fermentation processes, processes to make antibiotics and amino acids. Discovered a new method to produce a new semi-synthetic penicillin.

11. Shih-Kung Kao, Ph.D. (1918-) China — Director, Atmospheric Turbulence and Diffusion Project, University Corp. for Atmospheric Research, Salt Lake City, Utah. Research into atmospheric turbulence, the diffusion of radioactive debris in the atmosphere and the wave motion in rotating fluid.

12. Stephen Moi Kee, Sc.D. (1903-) Honolulu, Hawaii — Entomologist and malaria specialist, Public Health Division, International Co-op Administration, San Francisco. Research in malaria and encephalitis.

13. Ken-Ichi Kojima, Ph.D. (1930-) Japan — Professor of genetics, University of Texas, Austin. Studies the genetics of populations as they relate to evolution.

14.	Albert Kudo, Ph.D.	Assistant professor of geology, University of New Mexico.
15.	Richard R. Kudo, D.Sc.	Zoology Professor Emeritus, University of Southern Illinois.
16.	Koichi Masubuchi, Ph.D.	Naval architect, M.I.T.
17.	Fumio Matsumura, Ph.D.	Entomology professor at the University of Wisconsin.
18.	C. C. Li, Ph.D. (1912-) China	Geneticist and professor of biometry, University of Pittsburg, Pennsylvania. Studies in methodology in mathematics and statistical genetics with respect to human populations.
19.	Kaz Mayeda, Ph.D.	Associate professor of genetics, department of biology, Wayne State University, Detroit, Michigan.
20.	John S. Mitta	Developed the use of chick sexing and founded the American Chick Sexing School.
21.	Joseph Minoru Ogawa, Ph.D. (1925-) Sanger, California	Associate professor of plant pathology, UC Davis. Development and control of plant pathogens on stone fruits, hops, tomatoes, and tropical fruits.
22.	Akira Okubo, Ph.D. (1925-) Japan	Oceanographer and research associate, Chesapeake Bay Institute, John Hopkins University, Baltimore. Studies in oceanic diffusion of contaminants due to turbulence and of the mixing processes in estuaries and lakes.
23.	Hidemi Sato, D.Sc. (1926-) Japan	Associate professor of biology, University of Pennsylvania, Philadelphia. Applications of polarized light to living biological systems. Research in the dynamic structure of the mitolic spindle and in the development of a high sensitivity, high resolution polarizing microscope.
24.	Steve N. Sato	Invented the non-mercurial medical thermometer. President, IVAC Corporation, San Diego.
25.	James Ming Shan Sun, Ph.D. (1918-) China	Mineralogist and research physicist, Air Force Weapons Lab, Kirkland AFB, New Mexico. Research in X-ray crystallography and geochemistry; physics of high pressure; and hypervelocity impact and cratering.
26.	Yun-Pei Sun, Ph.D. (1910-) China	Insect Toxicologist and chief entomologist, Shell Development Co., Modesto, California. Research into various aspects of insecticides.

27. William N. Takahashi, Ph.D. — Professor of plant pathology, UC Berkeley.

28. Haruo Tashiro, Ph.D. — Professor of Entomology, Cornell University, New York.

29. Yu Chen Ting, Ph.D. (1920-) China — Associate professor of cytogenetics, Boston College, Chestnut Hill, Massachusetts. Determined chromosome number, and induction of flowering in the sweet potato plant. Research on chromosomes of maize, teosinte, and tripsacum; chromosome inversions in maize and teosinte (evidence of teosinte introgression in maize).

30. William T. Yamazake, Ph.D. — Professor of agronomy, Ohio State University.

31. John Teng Chien Yen, D.Sc. (1903-) China — Professor and chairman of the department of geology, Villanova University, Pennsylvania. Studies of marine and land gastropods of China and fresh-water mollusks of the western U.S.

32. Chia-Shun Yih, Ph.D. (1918-) China — Professor of hydrodynamics, University of Michigan, Ann Arbor. Research in hydrodynamics; gravity effects in fluid flow; rotating fluid; non-homogenous fluids; and magnetohydrodynamics.

BIBLIOGRAPHY

Asimov, Issac. *Asimov's Biographical Encyclopedia of Science and Technology.* New York: Doubleday and Co., Inc., 1972.

Bellox, F. "Great American Scientists". *Fortune Magazine*, March, 1960, pp. 236-242. (Comprehensive and interesting article on Nobel laureates, Yang and Lee).

Bolton, Sarah. *Famous Men of Science.* Crowell, 1960. (Book about Chinese-American Nobel laureates, Tsung Dao Lee and Chan Ning Yang, is for grades 4 and up).

Breuer, Hans. *Columbus Was Chinese: Discoveries and Inventions of the Far East.* New York: Herder and Herder, 1972. (An easy to read, interesting, and factual account of the many contributions the Chinese have made to science and technology).

Cattel, Jaques, editor. *American Men and Women of Science.* New York: Jaques Cattel Press, 1971.

Cohle, T. J. "Ghetto Kids on Science and Scientists". *Science Digest*, 77:54-9, January, 1959.

Cooper, E. K. *Silkworms and Science.* Harcourt, 1961. (This book is for grades 4-6. The history of silk and its discovery in China is presented, with instructions on the raising of silkworms).

Daumas, Maurice, editor. *A History of Technology and Inventions-Progress Through the Ages.* New York: Crown Publishers, 1969 (Volume 1: *The Origins of Technical Civilization).* (Two volumes are completed and two more are being written. All are profusely illustrated and contain excellent bibliographies after each chapter. Chapter 10, "Techniques of the Far East," and Chapter 11, "Techniques of India," contain valuable and informative material).

Debus, Allen G., Editor. *World Who's Who in Science.* Chicago: Marquis, Who's Who, Inc. , 1968.

_____. Volume 2: *The First Stages of Mechanization.*

Herman, Masako. *The Japanese in America: 1843-1973.* Dobbs Ferry, New York: Oceana Publications, Inc., 1974. (This book presents important events related to Japanese-Americans in chronological order. The last half includes documents, a list of scientists and a Who's Who of the Far East).

Hosokawa, Bill. *Nisei--The Quiet American.* New York: William Morrow and Co., Inc., 1969. (This general history of Japanese-Americans includes a list of notable personalities).

_____. *Japan in Transition*, Ministry of Foreign Affairs, Japan, 1975.

_____. *Japan*, Volume XI, #4. Ministry of Foreign Affairs, Japan, 1974.

Modern Men of Science. New York: McGraw-Hill, 1966. (426 scientists are listed).

_____. *Minority Profiles*. NASA

Mochè, Dinah L. *Women in Science*. (Illustrated interviews with cassettes and slides). Stony Brook, New York: American Association of Physics Teachers, State University of New York. November, 1975.

Needham, Joseph, F.R.S. *Clerks and Craftsmen in China and the West*. Cambridge: University Press, 1970.

Pine, Lilie. *The Chinese Knew*. New York: McGraw-Hill, 1958. (This book is for grades 3-7. A history of Chinese inventions and a number of suggested classroom experiments are included).

Sung, Betty Lee. *The Story of the Chinese in America*. McMillan Co., Inc., 1967. (A general history of Chinese-Americans. Important scientists and and other personalities are presented on pages 286-317).

Trevor, Williams I., editor. *Biographical Dictionary of Scientists*. Wiley-Inter-science, 1969.

Venzmer, Gerhard. *5000 Years of Medicine*. New York: Taplinger Publishing Co., 1972. (This book gives an historical account of diseases, cures and non-cures, and the men and women associated with them. Mesopotamia, Egypt, China, Greece and Italy are a few of the countries covered).

AMERICAN INDIAN CONTRIBUTIONS TO SCIENCE, MEDICINE, AND TECHNOLOGY

Prepared by

Mary Domb Mikkelson

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Jerry
Elliott

IMPORTANCE OF RECOGNIZING AMERICAN INDIAN CONTRIBUTIONS TO SCIENCE, ENGINEERING, AND MEDICINE

The following paragraphs have been excerpted and combined from speeches given by Jerry Elliot, a NASA aerospace engineer and an Osage/Cherokee Indian. One speech was presented during National Native American Awareness Week (October 14, 1976); another for the University of Oklahoma/NASA Space Symposium ("Careers for Tomorrow," March 17-18, 1977); and the third, "Mother Earth...Father Sky" at the NASA/Oregon State University Symposium (April 27-28, 1977).

.....The central theme of Native American Awareness Week (October 10-16, 1976) is to focus national attention on the many positive achievements made to society by American Indians and to more realistically portray the true image of American Indians in modern America. The non-Indian is seeking a new understanding and appreciation of the Indian in modern society. To them, we want to bring the real image of our native people, and destroy the distortion of which we have been the victims so long. These days an Indian doesn't need to dress or act like an Indian because he <u>is</u> one. Today we exist everywhere and are making notable contributions in education, law, medicine, art, business, science, and literature. This represents the greatest growth and self-determination that has ever been assembled in the two hundred years of this country's existence.

.....Despite the grave problems that face us, the greatest goals American Indians face are with our young people. We are proud of our past, our heritage, and find deep meaning in our ancestry. But what are we going to pass on to our children for the future? The future of our people lies in the hands of our youth. We are a people who know where we have been and where we are going. But if our children are to look forward to anything in the future, it is important that we retain our Indianness. We need to hold on to what is important to us as Indian people. Today, more than ever, it is important that we listen to our older people so that our children may enjoy a future Indian life. For us to survive, our younger generation needs to understand and retain our values and beliefs.

.....the story of the Indian in America is something more than the record of frequent aggression, greed and broken promises by the white man. It is more than turquoise jewelry, beads, braids, and John Wayne movies. It is a story of endurance, of survival, of adaptation and creativity in the face of overwhelming obstacles. It is a story of enormous contributions to the country---

Today, I see a new day.
This week, I see a new beginning.
This year, I see a new future.

Let us walk with peace and beauty in our hearts and accept that which will produce good things for our people. Let us touch. Let us, each to the other, nourish each other. Let us not destroy ourselves by forgetting that we are all Indians. Let us have a common voice that can be heard. I offer a prayer to keep our people together. This is the day the spirit speaks to all our men and women.

Yesterday, we were disappearing as snow before the setting Sun. But I strongly believe in my heart that we are not a vanishing race, only an unconquered one.

From where the Sun now sets in the father sky, let the winds of change blow in a new direction for our people.....

We need to reach out and grasp that which is needed for our survival. We need to seek skills that will provide us a sense of worth and purpose.....

.....Technology is touching all of our lives. But what is science and technology? Actually, it has to do with interpreting the physical world, the world around you everyday. It is the classification of Mother Nature. To the Indian, it is studying and appreciating Mother Nature in the ways we have always respected, but in another way. It comes under the category of new knowledge.

The Navajo wise men say science has a definite place in mankind's environment. Since science is knowledge of the laws of nature, they believe the more one goes about acquiring this knowledge, the closer one comes to the mysteries of the universe and to the Great Spirit.

Engineers and scientists are doers. They make things happen. It is not science that is harmful but how it is used that may be harmful. Problems that face us today, such as the energy crisis, environmental pollution, unwise development of resources, and using space for the benefit of mankind, cannot be solved without the aid of the engineer.

We need sound leadership to protect our land and our resources and to meet the needs of our people. We can no longer afford to drift.

There can be no turning back as a race, as a nation or planet. To do so could prove to be a guarantee of extinction. Since our very survival is dependent upon how well we are prepared for the future, none of us should play down the importance of the technical opportunities available to us. When we turn our back on the future to concentrate on the present, we cannot see what lies ahead. We cannot allow ourselves to become shortsighted.

The dwindling resources, pollution, and contamination of the Earth, our Mother, are examples of some people's shortsightedness. And many still have blinders on. We need young, fresh minds to help solve these problems.....We need you to accept the challenge. Yes, you are the future of our people.....If you let it happen!

A HISTORY OF AMERICAN INDIAN SCIENCE

They came, it is thought, from the mountainous land now called Siberia and they came, a few at a time, over uncounted thousands of years[1], and reached the Western Hemisphere by crossing the Bering Strait. Of many tongues and of varied (but generally Mongoloid) stock, these primitive wanderers (the earliest were of the Stone Age) from an isolated country knew nothing of other peoples or their accomplishments. On their own, in a new and untouched world, they were to develop over the centuries cultures remarkable for their contributions, inventiveness, and scientific "oneness" with the laws of nature. Spurred undoubtedly by the hard necessities of their lives (the search for food, shelter, and safety in unfamiliar surroundings, and the limitations imposed by their simple tools and a scarcity of tamable animals), they learned to investigate and respect the world around them and to cultivate and preserve its riches. In the process, the nomadic hunters who became North, Central, and South America's "Indians" (a latter-day misnomer resulting from Columbus' belief that he had reached India) also became both natural agronomists and the first true environmentalists.

Believing that all aspects of life were governed by nature, the American Indians learned in the years following their arrival to revere "Mother Earth"[2] (who, together with the sun, was considered the source of life) and strived to live in harmony with her. Staying "in balance" with nature was essential not just to their well-being but to their very survival. Accordingly, it was as wrong to offend the water gods by polluting their domain (led to illness) as it was necessary to placate the spirits of newly killed animals and celebrate the planting of the corn crop (rituals which promoted respect for animal life and for the land). Most of them took from nature only what was necessary; used contraception to prevent the birth of children neither they nor their earth could support; and followed myth-based agricultural practices which revealed their powers of observation (planted beans and corn together, thereby achieving a balance between the corn's depletion of soil nutrients and the beans' restoration of them) and their modernity (sang to their plants).

Those first Indians roamed the hemisphere, following the prey (mammoths, giant camels, and mastodons) they hunted with rocks and stone spears. As the supply of animals lessened, however, they became increasingly dependent on plant life and on their ability to utilize, adapt, preserve, and store the products of nature and, most important, to develop new food crops.

Starting with teosinte (teocintli), a wild grass of Central America, Indians throughout the Americas spent hundreds of years developing what is now the world's third most important grain[3]. Continually observing and experimenting

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[1] Recent evidence suggests that this migration began between 50,000 and 100,000 or more years ago.

[2] In the Navajos' story of creation, a tale now especially prophetic, Changing Woman and the sun were the parents of twin heroes who saved the world from monsters living here when the first people arrived. From their father, the sun, came the technology used to slay the monsters.

[3] Corn, which requires complicated care and cannot be scatter planted, is the most highly developed grain known. Some researchers believe this to be an indication of its age and of, therefore, the possibility that Indian civilization could predate all others.

(scientific techniques which probably resulted from their "taste and take the consequences" introduction to the plant life of the New World), they harvested, sowed, crossbred, and processed the grain, eventually producing over 300 (or more) varieties of maize (corn). Among them were corns requiring anywhere from 70[4] to 180 days to reach maturity; corns which grew best in the south or the north; drought-resistant corn which thrived in the arid southwest; yellow corn and white corn[5]; regular corns (flint, dent, flour, and sweet) and popcorns; every major corn variety known today. (Archeological finds made in New Mexico's Bat Cave provide interesting evidence of these centuries of cross-breeding. Uncovered there were both small, extremely primitive, huskless pop and pod corns and much newer varieties with husks and larger cobs and kernels. The older ones resemble early Paraguayan corn; the newer corns appear to be a hybrid, part-Mexican strain.)

Corn was but one of an amazing number of food crops (over 80 of the approximately 120 known) domesticated by the early Indians[6]. Almost one-half of the world's food supply results from their efforts. Among the plants known to them were potatoes (white and sweet); avocados; a number of beans (including kidney, lima, green and string), squashes, pumpkins and peppers; tomatoes; chocolate; peanuts, pecans, cashews, Brazil nuts, and butternuts; blackberries, raspberries, and two varieties of strawberries (which were later used to improve the non-too-sweet European variety); eggplants; pineapples (which only later were exported to Hawaii); Jerusalem artichokes; tapioca, wild rice; maple sugar and syrup (with which many Indians sweetened their popcorn--a treat much like today's Crackerjacks); vanilla; allspice and arrowroot and guavas, grapes, pawpaws, sapotes, papayas, one variety of persimmon, and certain cranberries.[7]

This remarkable achievement reflects three basic approaches to crop management--development of plants from wild growths through crossbreeding; domestic cultivation of previously wild plants and use of plants still in the wild state. It also reflects the Indians' skill in producing edible foods from poisonous plants--grating manioc roots, for instance, then pressing out their deadly juices to obtain both tapioca and arrowroot. (Other techniques included roasting cashews in their shells, a treatment used for rendering their juice non-poisonous, and a complicated process for leeching out the tannic acid in the acorns used to make flour.) They also devised the now-standard procedures for extracting maple syrup and processing it into sugar; for obtaining vanilla extract from unripe pods (drying them, then removing the crystals that formed on the outside); and for alkali processing systems that increased and improved the niacin and amino acid content of corn.

As Indian agriculture became more extensive (Columbus reported cornfields up to 18 miles in length), the development of techniques for irrigation (especially in the rain-starved southwest), dry farming, soil care, and fertilization became essential.

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[4]To insure full growth before the frost in areas with very short growing seasons (under 70 days), they soaked the corn in water before planting it.

[5]The Miamis' white-meated corn was regarded by other Indians as the finest grown.

[6]Because of the great time period involved in the domestication and hybridization of corn, it is doubtful that the European settlers of the new world could have even begun to accomplish what the Indians had.

[7]The prepared foods originated by the Indians include cornbread, hominy, succotash (contained fish then), corn tortillas, baked clams, persimmon and cassava breads, clam chowder, oyster stew, corn soup, pumpkin pie, cranberry sauce and "Boston" baked beans.

The pre-historic Hohokams (ancestors of today's Pimas), who had only wooden tools and their hands with which to work, were the first to use canal irrigation. The ditches they dug to carry water from the Salt and Gila Rivers ranged up to 16 miles in length and connected systems spreading over as much as 150 miles. The Pueblo Indians employed both streams and reservoirs in their systems, while the Saladoans of the Arizona and New Mexico mountains built canals that have been incorporated into the systems of today.

The early Indians were also far ahead of the rest of the world in their use of fertilization (the Abnakis of Maine, for instance, used fish to enrich their fields; the Algonkians, seaweed) and crop rotation (kept some fields going for hundreds of years). Food preservation and storage were important to them, too, and they used such techniques as drying (meat and fish[8]); wrapping food in birch and other barks; underground crop storage; and smoking (especially popular among Gulf Coast peoples[9]).

Although farming became a vital part of Indian life, hunting and fishing also remained important and creativity was evident both in the animal disguises worn when approaching prey, and in the variety of specialized tools and techniques they employed. The Iroquois, for example, used fish nets made of vines and dammed their streams to make fishing easier. The Nootkas of British Columbia and Washington used a paddle-shaped board with teeth on one side to snare herring and developed a complicated harpoon system for whaling. Bows and arrows, boomerangs (for rabbits), pitfalls, concealed corrals and snares (for birds) were used by Indian hunters, as was water (for drowning prairie dogs and other rodents out of their burrows). Thanks to their talent for careful observation, they quickly learned the best woods and stones for making bows and arrows and how to heat grooved stones for use in straightening arrow shafts. They also studied the animals and, by watching where and when they ate or traveled, gathered knowledge that made hunting more profitable. Going a step beyond hunting, they domesticated the turkey and raised it for food. In the years after the Europeans introduced the horse in America, the Nez Perce of Oregon and Washington (the only tribe to practice selective breeding of stock) developed the Appaloosa, one of the finest saddle horses known.

Food crops were not the only contributions made by these early agronomists. The Indians of Central and South America used rubber products hundreds of years before Columbus reached the New World. Having first devised a means for extracting and treating the sap of rubber trees, they then made tightly-compressed, high-bouncing balls (and originated games to play with them), waterproof bags, clothes, and boots.

Long staple cotton, which was made into clothing by the Indians long before the Europeans had even heard of it, is a finer, stronger variety (so fine the white settlers thought it was silk) than that of the Egyptians.

Chicle (the main ingredient of chewing gun), tonka beans (their fragrance is prized by perfumers), decorative gourds and, of course, tobacco (40 or more varieties were developed, mixed, blended, and used in widespread trading operations) were also products of Indian agriculturists.

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[8]Another important commodity, salt, was obtained by evaporating saturated solutions--taken from salt licks--over a fire.

[9]In a typical year a tribe of Northwest Coast Indians would stock upwards of half a ton of dried salmon.

They were also extremely knowledgable in the medicinal use of plant products, so much so that....."in 1952 Felix S. Cohen could write '.....in the 400 years that European physicians and botanists have been analyzing and examining the flora of America, they have not yet discovered a single medicinal herb not known to the Indians.'"[10] Their extensive knowledge of plant types, relationships, and uses, a knowledge developed through centuries of observation and experimental usage and conveyed by word of mouth from one generation to the next, grew into highly accurate and still useful classification systems, some of which listed plants not by appearance or general type but by what is now known to be their chemical composition (steroids, hallucinogens, vitamin C content, etc.).

Quinine, obtained by South American Indians from cinchona bark and used to cure malarial fever, was one of their major drug discoveries. Coca leaves (from which cocaine and novacaine are derived) were used as an anesthetic by the Incas (and others) long before the Europeans had this important surgical aid. The Indians of prehistoric America used narcotics, emetics, cathartics, and febrifuges and at least 59 items included in today's pharmacology were developed by them, such as arnica, petrolatum, Ipecac, curare, cascara, wintergreen, cannabinum, datura and iodine (as was a suntan lotion made of red ocher and animal fat). Crude oil was used by at least one tribe, the Wenrohronon of New York, to treat burns, dry skin and, when mixed with other medicines, stomach pains and constipation. A variety of effective contraceptive herbs, among them stoneseed, dogbane, Indian turnip and squaw root, were also used--some of them in individually prescribed and adjusted oral doses. (see page 38 of the Hispanic chapter for a discussion of medical practices among the Aztecs, Incas, etc.)

Indian "doctors" were generally well informed about the medicinal value of local herbs and minerals. This knowledge, along with an appreciation of psychotherapeutic techniques and the dramatic impact of "supernatural", religion-prescribed, Shamanistic rituals in which faith was the main curative factor--cupping, blowing, rubbings and sucking out of the body the foreign agents (snakes, birds, etc.) which caused sickness--combined to make their medicine quite effective. (Faith in traditional medical practices is still strong today and the modern Indian doctor often works hand-in-hand with the medicine man.) Shamans, each of whom practiced a specialty, were employed to treat serious illnesses while herbalists (usually women who also used massage and diet in their treatments) cared for more routine sicknesses.

A belief in maintaining the proper balance of physical and mental health and in the importance of dreams was among the factors which led the early Indians to develop ideas much like those of modern psychology. It was recognized that dreams revealed hidden wishes and guilts and it was considered dangerous to hold them in. Most were told in secret (a practice especially prominent among the Iroquois) to interpreters. The telling of dreams helped relieve tension, as did certain ritualistic festivals, especially those held during the harsh winter season. Some dreams had to be obeyed; some were poisoned or bewitched by evil spirits and could result in the loss of the dreamer's soul. Others (which provided guidance[11], religious ecstasy, stature or dominance over the animals they hunted) were actively sought and often induced with drugs.

[10] *Our Indian Heritage-Profiles of 12 Great Leaders.* C. Fayne Porter. Chilton Book Company, Philadelphia, 1964.

[11] Among the Diegueños, for example, the Shaman's medical specialty was revealed to him in a dream.

Perhaps the best-known drug usage, one which started in Mexico then traveled north, is that practiced by members of the Peyote Cult. Alkaloid-containing buttons (the only part of a small, spineless cactus which grows above ground) are chewed or made into a tea to induce trances in which occur visions of great beauty and happiness. Its use, as a result, is regarded as an opportunity to know and experience God. Another brew, made from the Jimson weed, was also used by certain California Indians to produce visions.

Bonesetting was also among the Indians' medical skills[12], as were bloodletting (to force out infection and, possibly, treat high blood pressure); the inhalation of herb-tinged steam; the use of enemas; and surgery, including trephination. Far more knowledgeable about good health practices than any other people of their time, they bathed frequently (a practice Queen Isabella of Spain ordered halted for their own good): invented the first toothbrush[13]; filled dental cavities with gold[14]; ate well-balanced diets; and, incidentally, domesticated the guinea pig so essential to today's health studies.

The average European of Columbus' time was only five feet tall and had a one-in-ten chance of being physically or mentally deformed (conditions which could be attributed to dietary deficiencies). It has been speculated (Fadden, "On Indian Contributions to the United States"--see bibliography) that both small stature and a large number of deformities might still exist if it were not for the foods, medicines, sanitation, and health practices given to America's settlers by the Indians. They gave the world many other gifts, too, among them hammocks, snowshoes, canoes, sleeping bags, toboggans, and the games of lacrosse, hockey, and marbles. By the 15th century, Indians had also invented such tools as the reciprocating two-hand drill, the bow and strap drill, and the continuous motion spindle. (Although not a scientific contribution, it is well to note that our democratic form of government--including the idea of two congressional houses and the very concepts of union and "government of, by and for the people"--was directly derived from that of the Indians; many tribes, most notably the Iroquois, were centuries ahead of other cultures in such matters as women's suffrage and outlawing slavery.)

One of the finest Indian gifts was that given by the great Sequoyah to his own people. It involved, thanks to Sequoyah's curiosity and dogged determination, a scientific/experimental approach to answering a question and solving a problem. Born (circa 1760-1775) in a Cherokee village in Tennessee, Sequoyah was the son of Wut-ten of the Red Paint Clan and a white father--probably Nathaniel Gist, a hunter and explorer. His mother's people were conjurers and spell casters; his father's ran to statesmen. An illiterate, untutored, introspective genius whose work as a craftsman and silversmith had developed in him the qualities of patience and careful attention to detail, he was fascinated by the whites' ability to communicate with one another with "talking leaves," marks made on pieces of paper. When he could not get word from home during

[12]Ruth Farrell Almstedt, in her "Diegueño Curing Practices," reports that the Diegueños made splints from green elm bark which was tied around the broken limb with wet buckskin. As they contracted the splint became rigid and swollen joints absorbed the soothing juice from the bark. Another, much earlier, use of this basic technique was the Eskimo's method of attaching handles to tools with rawhide, which bound the parts tightly together as the hide dried and shrunk.

[13]South American Indians

[14]Peruvian Indians

the War of 1812 (he fought for the U.S.), this fascination became an intense longing.

When, after the war, he decided to create a written language for the Cherokees, it was perhaps a very good thing that he didn't know the job was "impossible". Using charcoal and sycamore bark, he first experimented with picture writing, drawing a different mark for each word. After his wife, angered by his neglect, burned his store of bark words, he left home, taking his six-year old daughter, Ah-yoka (he also had several sons) with him and settled in a deserted cabin several miles from his home and started over. His approach changed after Ah-yoka found a book someone had lost. Although he could neither read, write, nor speak English, he studied the book and soon realized that the patterns (letters and words) were repeated again and again. Deciding that each of the 26 marks represented a different sound, he concluded that only a few sounds would be needed to write all the words he knew and started the project anew. Beginning with 200 sounds, he used some English and some original letters and wrote out messages his daughter could understand. Scorned by the tribe, he moved to Arkansas and spent another three years working on his syllabary; a syllabary he trimmed by eliminating unnecessary syllable combinations, to only 86 characters. (The Cherokee language has been described as having nine modes, 15 tenses, three numbers--singular, dual, and plural, few pronouns, no prepositions, and since they were contained in the verbs themselves, no auxiliary verbs.)

He was, after much debate, allowed to present his writing to the Tribal Council and, when 10 year old Ah-yoka was able to read a message dictated to her father, suddenly became a hero. Within only a single year, the shortest such journey on record, the Cherokees progressed from having no written language to possessing a very high degree of literacy. Print in the Cherokee language, and the first Indian language newspaper (the *Cherokee Phoenix*), magazines, and schools followed and Sequoyah was awarded a medal and yearly pension by the Cherokee Nation. Not content to retire, he next undertook an expedition to the southwestern United States and Mexico to search for words that would establish a common heritage among Indian tongues. Death, in 1843, ended his search, but his syllabary lives on. The first statue placed in the Statuary Hall in the Capital Building was of Sequoyah and in his honor have been named a mountain, a county in Oklahoma and the giant redwoods of western America.

Another gift, the Indians' tipis (teepees, wigwams)--forerunners of the Sibley Army tent--featured advanced engineering concepts which, strangely enough, are not part of today's tents. Invented, most likely, to keep out the Arctic cold, they were also useful in warmer climates. A bottom section which could be raised allowed cooler air to flow in along the ground then, as it warmed, to rise and escape through a hole in the tipi's top. This opening served also as a chimney for indoor fires (far from practical in most present-day tents). Such automatic and controlled ventilation was also found in their windowless lodges where air (which entered through a partially opened door) was warmed by the central fire and was passed out through the smokehole over it; the outward flow drawing in more fresh air to keep the cycle going.

A wide variety of engineering and architectural skills were employed by the Indians of early America; the skills of a particular tribe reflected their environment and needs. The Incas of Peru designed and built four lane highways,

some of which are still in use; tunneled through mountains; and constructed suspension bridges to allow passage across the steep gorges of their country. Using stone mortar and a form of concrete, the Aztecs, Toltecs, and Mayas built flat-topped pyramids (hundreds more than did the Egyptians) and placed their temples and palaces atop them. (See Hispanic Section). The Mississippi Valley Indians also built pyramids of stacked rubble covered with earth and topped them with wood and thatch buildings. Working without even the most basic of machinery (they carried dirt in baskets and hide aprons), the Mound Builders constructed approximately 100,000 mounds. Besides the dwelling-topped habitation mounds, they erected burial mounds for prominent members of the tribe; effigy mounds (probably religious in nature) of various birds and animals; and giant temple mounds. The largest temple mound is 99 feet high, covering 16 acres--three acres more than Egypt's Giza Pyramid.

The pueblos of the North American Southwest (approximately 15,000 were built in Arizona and New Mexico) were another amazing engineering accomplishment. New Mexico's Bonito Pueblo, which was built in the early 900's, is five stories tall, approximately 700 feet long and 300-plus feet wide and contains more than 500 rooms. Built of stone or sun-dried brick cemented with adobe (a local clay), they were topped first with peeled aspen or willow, then with thick layers of mud and desert clay; construction techniques that effectively air-conditioned them in hot weather and, at the same time, made them easier to heat in the winter.

The Zuni, who built with wood, used a mixture of ashes, coals, and dirt as a mortar while the Indians of the Northwest, for whom wood was especially plentiful[15], used mortising in their building and steam boxes to shape the wood.

The Saladoans were also good architects, constructing multi-story houses and surrounding their towns with great walls.

Notable accomplishments in math and astronomy are credited to the American Indian. The Powhatans (the tribe of Pocahontas), for example, understood the decimal system; used knotted strings or notched sticks to keep records; divided the year into lunar months and recognized five seasons--the time of budding or blossoming; the time of the earing or roasting of corn; the time of the highest sun; the time of the corn harvest or the fall of the leaves; and the time of cohonks (the sound made by the wild geese as they returned each winter). The Indians of Yucatan used advance math and knew that the world was round and revolved around the sun. (The Caracol Tower at Chichen Itza and several other structures, most built by the Quetzalcoatls, are believed to have astronomical significance.) The mathematical and astronomical knowledge of the various Central and South American tribes (Aztecs, Toltecs, Incas, Mayas, etc.) is well-documented (See Hispanic Section). It is now believed, thanks to new studies of the Big Horn Medicine Wheel[16] in northern Wyoming (a massive rock

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[15]Using chisels, adzes, and knives with blades of shell, they worked soft cedar into yarn and pounded it into a soft padding used to line cradles. Clothing made of woven bark shed water and dried quickly, valuable qualities in their wet climate. They also used copper (obtained from Canadian tribes), shell, and mica as decorative inlays for wood, carved helmets, and designed wooden body armor. (The Tonkara used hide vests as armor.)

[16]The word medicine, as used by the Indians, meant magic or supernatural and generally had a religious connotation. The Medicine Wheel's resemblance to the floor plan of a ceremonial medicine lodge led to the belief that their functions were similar.

arrangement apparently aligned to the summer solstice), that the prehistoric natives of the Great Plains understood both solstices and seasonal changes and, possibly, could predict eclipses. Navajo legend tells of Coyote watching the God, First Man, carefully and oh-so-deliberately arranging the stars. Becoming impatient with the other's slowness, it is said that Coyote seized the stars and flung them into the sky, creating a random pattern--a "Big Bang" theory hundreds of years older than George Gamow's.[17]

Artistic urges led the early Indians to a number of scientific discoveries. The Hohokans made, on shells, what are believed to be the world's first etchings, using an acid made by fermenting juice extracted from the fruit of the saguaro cactus and a resist of gum or pitch to work their designs. The Havasupai mined red ocher in the Grand Canyon and used it to make a very high quality paint. (Paintings made on exposed rock walls over 2000 years ago can still be clearly seen.) The metal workers of the prehistoric Hopwell Culture (in the North of Mexico), who made beautiful ornaments and decorations, invented many delicate tools with which to beat and anneal copper, iron, and occasionally, silver and gold. (Underground mines were worked by many tribes long before the whites came to America.)

Dyeing and tatooing were common, as were pottery making, basketry, weaving (of cotton, wild fibers, hair, etc.), toymaking, jewelry styling, and the making of wampum (shells of various sizes and colors, drilled and strung to make arrangements used to record tribal legends and history). Most wampum makers bored a hole through the center of a flat shell then polished and strung it. The Algonkians, however, carved a long strip from the shell (clam), sanded it into a cylinder and bored it lengthways, using a fine stone drill or a wooden one dipped in wet sand.

Other early accomplishments were the development of an international sign language which made communication between tribes easier; the working of turquoise and carving of stones; and the use of red hot stones to boil water in baskets or in cleaned buffalo stomachs (where fireproof pots did not exist). Mortars were cut from basalt boulders by the early Indians of California's San Nicolas and San Clemente Islands and their manufacture may well have been a business. Everything from travel modes (travois, sleds, different boats, etc.) and delicacies (i.e. a whipped ice-cream-like mixture of soapberry, cold water, and olachen oil) to dietary necessities (i.e. salmon "cheese"--salmon stored in a box until "more than runny") were created from what was available.

Acceptance and use of the available is perhaps the best description of the Indians' approach to science and to life. They developed and lived by a culturally rooted, mystical system through which they attempted to understand and explain their world and to be a part of and grow with nature--a metaphysical ethnoscience. Because they had no written language throughout much of their history, the Indians' knowledge was passed along by word-of-mouth--via families and moieties (two equal divisions of a tribe, as wolf and raven moieties)--and in the fables and myths of their religions. That system was truly a science, not one wrapped in the equipment and procedures of today but an attempt to understand and relate to natural phenomena. And that, interestingly, is a road science; and this road science, in the name of ecology, is once again traveling. The American Indian, who never left the Pollen Path

[17]See Bibliography entries, Albert J. Snow.

("Walking the Pollen Path" is the Navajo expression for being at one with nature), now has a chance to walk in the vanguard of modern science--as, indeed, many are.

WELL-KNOWN INDIANS IN SCIENCE, ENGINEERING, AND MEDICINE

ENGINEERING, PHYSICS, AND ARCHITECTURE

Ely Samuel Parker. Born Hasanvanda of the Seneca Iroquois, Mr. Parker took an Anglicized name because in his time little respect was paid to the bearer of an Indian one. A stable boy for the Army by the time he was 10, he entered a missionary school after being teased about his poor English. Eager to help his people, he studied law but was refused admission to the bar because of his race. He then studied civil engineering at Rensselaer Polytechnic Institute and upon finishing, went to work on the Erie Canal. Hired by the government to supervise the construction of levees and buildings, he found himself in Galena, Illinois, where he made friends with a harness store clerk named Ulysses S. Grant. When the Civil War started, he returned to New York to put together a regiment of Indian soldiers but the state's governor refused their services. Rejected also by the War Department, which was in desperate need of engineers, he took his problems to Grant. Several months of red tape later, Parker was ordered to Vicksburg and from there went with Grant to Richmond where, because of his beautiful penmanship, he was asked to write out the surrender terms signed by General Lee. By then a Brigadier General, he was often sent to settle differences among the various Indian tribes and, when Grant was elected president, he became the first Indian to be named Commissioner of Indian Affairs. Backed by Grant, he began cleaning up that corrupt office, often filling important jobs with Quaker volunteers. Caught between Indian needs and white government policy and deceit, he treaded a very shaky tightrope until, finally, his efforts to feed starving Indians led to charges of misconduct, and he resigned rather than hurt his people or embarrass Grant. Moving to New York, he went into business and became a wealthy man.

Ronald Ray Bourassa, Ph.D. (1940-). Born in Oklahoma City, Dr. Bourassa can trace his heritage through the Potawatomis back to France in the 1600's. Two of his direct ancestors, Jude Bourassa and his brother, Joseph, became a part of history in the early and mid-1800's when Jude (who, along with Chief Godadomva Cheves, was described by the President of the Board of Catholic Missions in Missouri as a "principal agitator") wrote many letters trying to gain support for a tribal doctor; Joseph (who was always active and influential in tribal affairs) served as an instructor at Choctaw Academy and as tribe interpreter (from 1844 to 1860).

Dr. Bourassa's paternal grandfather was, starting in 1904, one of the first automobile mechanics in Potawatomie County, Oklahoma and was later hired as a diesel engineer by the Sinclair Oil Company. His maternal grandfather was for 20 to 30 years the County Commissioner. His father, now retired, worked for 30 years for the Parts Division of General Motors; his mother, as an elementary school teacher.

Valedictorian of his high school class of 400 students, he won a full scholarship to Rice University, then went on to receive an M.S. and Ph.D. in physics from the University of Illinois. After a year as a senior scientist at Battelle-Northwest, he joined the University of Oklahoma as an assistant professor of physics. Now an associate professor of physics and astronomy[18], he was in 1974-75, a Senior Fulbright Research Scholar in Julich, Germany and, in 1975, received his school's Sigma Xi award for outstanding research. Listed in numerous who's who-type directories, he has used the thermoelectrical power of metals as a tool to investigate properties of vacancies and substitutional defects in aluminum, gold, silver, copper lead, and indium.

The first person to use high pressure to investigate vacancies in metals, Dr. Bourassa solved a long-standing problem by his measurement of the migration energy for vacancies in copper. His group was the first to experimentally investigate the Nielsen-Taylor effect (which he named) and their measurements on the size effect in the noble metals is the only work that looks at all three noble metals in the same experiment. His collaboration with a colleague in astrophysics produced the first solution to the problem of the gravitational lens for extended objects. His latest work (with several other investigators in Germany) on cyclotron masses and Fermi velocities in the noble metals by deHaas-van Alphen effect, represents a monumental effort which he believes will become a classic for the thoroughness and accuracy of the data presented.

Dr. Bourassa splits his time about evenly between research and teaching, and has supervised four Ph.D. and one M.S. thesis (for him, the most thrilling of his teaching experiences). Formerly the sponsor of the Indian Graduate Students Association on campus, he is now co-sponsor of the American Indian Student Association. Among his other activities are a proposed program for educating Native Americans in physics, and a NASA seminar designed to interest American Indians in science and engineering. Married, with three children, he lists his hobbies as tennis, golf, and swimming.

Jerry Elliott, B.S. (1943-). Of Osage/Cherokee ancestry, Mr. Elliott was born in Oklahoma City. Now an aerospace engineer with the Space Shuttle Program at NASA's Johnson Space Center in Houston, he holds a B.S. in physics from the University of Oklahoma and has done post graduate work there, and at the University of Houston. He has also taken a number of special advanced training courses, both technical and managerial. His present responsibilities include assisting in the planning, defining, and implementation of the Space Shuttle Program and in assuring that crew-related spacecraft items meet program requirements. Additional duties involve the development of programs meaningful to the American Indian, and the planning and coordination of symposia designed to motivate high school and college students, especialy Indians and other minorities, to seek careers in science and engineering. He joined NASA in 1966 as a flight mission operations engineer at the Mission Control Center and has since worked in the fields of spacecraft systems, hardware, software, trajectories, mission operation, earth resources, and scientific experimentation. As staff engineer in the Apollo-Soyuz Program Office in Washington, D.C., he was involved in onboard spacecraft and ground crew mission operations, requirements, and science experiments for the world's first Russian-American space mission. Among his many honors and awards is a Presidential Medal of Freedom Certificate for his service as retrofire officer at the Mission Control Center during the safe return of the crew of Apollo 13.

[18]All current positions listed are the latest known to the author.

An exceptional writer who has used his talents as an example to motivate Indian young people interested in science and engineering, Elliot was appointed national chairman of the First Native American Awareness Week, October 10-16, 1976. He also authored the Congressional legislation which made this week of recognition, the first national observance honoring American Indians, possible. He has been chosen as a community representative and practicing engineer in the American Indian portion of the first permanent outdoor exhibit depicting the advances and accomplishments made by minority engineers.

The author of a *Dictionary of Computer Terms*, he lists among his other activities and accomplishments (many Indian-oriented) that he recommended and received NASA's commitment to sponsor four American Indian engineering students (they were awarded $2500 renewable scholarships and received summer jobs at Johnson Space Center) and that he is looking into the possibility of bringing NASA-developed technology--in the form of solar powered housing and refrigerators, new waste treatment systems, and CTS Satellite educational programs--to Indian reservations. His other interests include music (membership in ASCAP), music education, and poetry (Poetry Society of Texas).

Alfred Qöyawayma Colton, M.S. (1938-). Of Hopi (Northern Arizona) ancestry, Al Colton was born in Los Angeles, California. He received a B.S. in mechanical engineering from California State Polytechnic University at San Luis Obispo; an M.S. from the University of Southern California (specialized in control systems and system analysis and simulation); and has participated in a USC graduate program in water resources and environmental engineering. A graduate of the Westinghouse International School of Environmental Management, he has also attended UCLA and Arizona State and is a registered professional engineer in California and Arizona and a member of several professional organizations.

After working for Litton Systems, where he served as a mechanical and electrical project engineer in the development of new high-technology systems and products, including inertial guidances systems (holds patents on several of those products), Mr. Colton joined the Salt River Project (an electric power and water utility serving Phoenix, Arizona) to form and manage their environmental department. As supervisor of the department, he "manages and coordinates activities for the air and water quality affairs, natural resource management, environmental program planning and corporate environmental credibility of the project." Two current activities of the department are the siting of both the Coronado Generating Station's 1050 coal-fired plant and all the transmission lines for the Palo Verde Nuclear Generation Station.

A member and leader of several professional, Indian-oriented environmental committees, Al also serves on the Bureau of Land Management's Arizona Multi-use Advisory Board and is a registered Arizona lobbyist. A potter (and a weaver), his works (which bear his Hopi name, Kuwanwisiwma Qöyawayma) have earned national attention and have been given the First Place 1976 Popovi Da Memorial Award at the Scottsdale National Indian Arts Exhibition, and two blue ribbons at the November, 1976 Heard Museum Indian Arts and Crafts Exhibition. (His aunt, Elizabeth Q. White--Polingaysi Qöyawayma--is a noted potter, writer, and educator; his father and uncles, well-known water color and oil painters.)

T. S. Ary, B.S. (1925-). The son of McKinley Ary (a Shawnee) and Emma Busby Ary (a Sioux), T. S. Ary (the name registered on his birth certificate) was

called Tecumseh Sequoia Arokta by his family; the family name of Ary was assumed by his great-grandfather following the Battle of Tippecanoe. From a family of coal miners, he was born in El Dorado, Illinois, and later lived in Evansville, Indiana. After graduating from high school (in the top 1% of his class and with honors in football, basketball, baseball, swimming, track, and boxing), he enlisted in the Naval Air Corps and was commissioned as a pilot. During his years of Navy service, he was a test pilot for carrier-based planes; a member of the Blue Angels flight exhibition team; attended several universities and participated in inter-collegiate athletics; and received all-conference honors in the Southeast Conference, the Big Ten, and All-Service Conferences; and All-American honors as a football, basketball, and baseball player. Following his discharge, he attended Stanford University and received a B.S. in mineral science (mining engineering and geology) while continuing his athletic activities (which, because of his Indian heritage, were especially popular with the nation's sports writers), joined Sigma Nu fraternity and served as president of the Geology and Mining Society. Upon graduation, he started his career as a mining engineer and geologist with Anaconda Copper Company. Moving to Union Carbide Corporation, he worked his way up from the position of mining engineer at Rifle, Colorado to that of Vice-President of the Union Carbide Exploration Corporation in New York City. Now with Utah International (in San Francisco), he is manager of the development department of the Australasia Division, a position which includes new business venture responsibilities and international exploration.

Personally responsible for several major mineral discoveries which led to mining and milling operations, he also managed an exploration department staff responsible for the discovery of several new major ore deposits in the United States and overseas. Active in many professional, governmental, church, and community groups and committees, he has also worked with several small Indian tribes as an advisor in their litigation over broken treaties (resulted in the recovery of several million dollars). Moreover, he has helped arrange scholarships for Indian students at top universities throughout the nation. Married, with one adult child, he lists biking, Ducks Unlimited, fishing, mountain climbing, photography, rose gardening, sailing, and skiing among his outside interests.

Arnold T. Anderson, B.S. (1915-). Now manager of urban and public affairs for the Chemical and Plastics Division of Union Carbide Corporation in New York City and a special assistant for the American Indian Policy Review Commission of the U. S. Congress, Mr. Anderson is perhaps best known for his work as one of the top scientists (he collaborated with Albert Einstein) involved in the development of atomic energy (the first atomic bomb) during World War II. A scientist, engineer, inventor, manager, author, and executive, he was born on the Grand River Reservation in Canada (a Tuscarora-Mohawk-Cayuga member of the Iroquois Confederacy) and attended reservation schools before earning his B.S. in chemistry from McMaster University in Hamilton, Ontario. Very Active in Indian and other minority affairs, he directs his company's equal opportunity program and holds membership and offices in many state and national groups (among them the National Science Foundation, American Indian Engineering Council, New York State Advisory Committee to the U. S. Commission on Civil Rights, Boy Scouts of America, Junior Achievement, American Security Council, Sierra Club, etc.). He is also a member of the board of directors of several industrial enterprises.

George Yates. A Pueblo Indian from the Nambe Pueblo in the Rio Grande Valley of Northern New Mexico, George Yates grew up on the reservation and attended a BIA (Bureau of Indian Affairs) day school through the sixth grade before being sent to the Santa Fe Indian School (a boarding school) where he graduated as salutatorian in 1956. He then participated in a four-year electronic technician apprenticeship program which sparked in him an interest in engineering. The responsibilities of a growing family (he and his wife now have four daughters and one son) made full-time college impossible but he has attended the University of New Mexico on a part-time basis for several years and is now a senior student working toward a degree in electrical engineering and computer science. Now an employee of the University of California's Los Alamos Scientific Laboratory, he worked first for the Eberline Instrument Corporation of Santa Fe where he aided in the design, calibration, and check-out of nuclear radiation detection equipment. At Los Alamos, Yates performs the electronic design and development of control and data acquisition instruments for use in the lab's underground nuclear tests at the Nevada test site and is a senior technologist (a title held by fewer than 20 of LASL's 5500 employees). He has been project engineer on several electro-optic research and development projects; authored and published two LASL reports; is responsible for several digital electronic circuits (some published in leading journals); and has applied for patents on three different systems.

Among his achievements are the design of a television camera system noteworthy for its high resolution, low cost imaging system, and the development of the first published non-linear approach to recognizing strategic portions of television video waveforms. Another system he developed synchronizes several distinct sources of video systems for transient-free display (which eliminates the need for the master-slave techniques commonly used to solve this type problem). He has also designed a TV camera used at the Nevada test site to measure neutron-generated images four times faster than had been previously possible and is currently working on a newer, faster, higher resolution, computer-controlled version of this camera, which uses such modern electronics as hybrid thick-film technology, micro-processors, digital-to-analog converters, mini-computers, etc. One of his patent research papers concerns a computer input communication device known as a "tablet," which uses a charged-coupled device for XY coordinate information (The computer used addresses any area in an XY plane--the tablet--simply by using a penlite to illuminate points on the light-sensitive tablet matrix.)

Involved in the Native American Program, College of Engineering at the University of New Mexico, he has seen Indian enrollment there go from four to 40. He is also a member of the American Indian Society of Engineering and Science, a national group dedicated to encouraging more Indians into these fields.

Neal A. McCaleb, B.S. (1935-). Of Scottish and Chickasaw Indian heritage, Mr. McCaleb was born in Oklahoma City. A graduate of Oklahoma State University, he was given the Outstanding Senior Civil Engineer Award by the Associated General Contractors; named in *Who's Who in American Colleges and Universities;* and received scholastic recognition from Tau Beta Pi, Phi Kappa Phi, and Chi Epsilon. Now president and chief executive officer of McCaleb-Nusbaum-Thomas, Architects and Engineers, Inc. of Edmund, Oklahoma, he had previously had his own consulting engineering practice and established Arrowhead Homes, Inc., a company involved in the development of residential subdivisions, recreational facilities, and office parks. A member of several professional organizations

(among them the National Indian Council of Architects and Engineers, of which he is chairman), he was also past president of the Chamber of Commerce; received the Jaycee's Outstanding Young Man Award; and has served on several Indian affairs groups (was a presidential appointee to the National Council on Indian Opportunity in 1972). An active member of the Republican Party, he has been a state representative and has held several local and state party positions. An instrument and multi-engine rated pilot who has logged over 1700 hours as pilot-in-command, he lists hiking and sailing as his other hobbies.

William Wayne Keeler (1908-). Now chairman and chief executive officer of Phillips Petroleum Company and principal chief of the Cherokee Nation, Mr. Keeler has had a distinguished career. Starting at 16 as a summer employee, he worked for Phillips in various capacities, moving up through the ranks until he became the company's president. Born in Texas, he headed the first United States Petroleum Industry exchange tour of Russia and has received many honors and filled a variety of top national and international posts in the areas of economic development and Indian affairs. Active in many professional and cultural groups, he was named to the Oklahoma Hall of Fame in 1966 and was named a Golden Plate "Giant of Accomplishment" by the American Academy of Achievement in 1969.

Fred Young, Ph.D. The only Navajo Ph.D. in physics, Dr. Young directs laser research in thermonuclear reactions at the Los Alamos Scientific Laboratory. A graduate of the University of New Mexico, he, while a research assistant there, helped design a space radiation measuring device for NASA. As a student at an Indian high school, he was told he wasn't smart enough to do anything but farm. And farm he did, until Air Force service as a ground support maintenance man led him first into engineering, then physics. He has developed a mathematical language which can be used to bridge the difficult gap between Navajo and English concepts and expressions, a language he teaches to promising Navajo students.

Alvin Bearskin, B.S. An aerospace and aeronautical engineer, Mr. Bearskin, a Wyandotte from Oklahoma who works for NASA, designs spacecraft equipment used in lunar flights. Twice a victim of polio, he nevertheless lettered in football at the University of Oklahoma; has worked in the past with heavy duty road construction equipment; and has taken part in a cold weather test in the northern Yukon.

Alexander Reifel, B.S. (1913-). Born in South Dakota, Mr. Reifel, a Dakota-Brule, earned his B.S. in civil engineering from the University of Wyoming. A designer of flood controls for the Army Engineering Corps, he also worked on irrigation projects for the Bureau of Reclamation.

Allan A. Fredrick (1910-). Always interested in mechanics, Mr. Fredrick, a Dakota-Yankton from South Dakota, worked his way, via on-the-job experience and an exhausting series of correspondence courses that enabled him to pass the exam for electrical engineers, to the position of Plant Management Specialist with the BIA. Among his special awards is a certificate honoring his wartime work in lighting and guarding, with the aid of Indian workers, the Owyhee, Nevada Dam.

George Owl, Jr. Mr. Owl, a Cherokee Indian, is a plane designer for the Los Angeles division of Advanced Concepts and has worked on the X15, B70, and TFX

proposals. As designer of the "Owl Racer", a formula one, sports racing airplane, he utilized a technique never before applied to this type plane and has received national and international recognition for his work.

Emil Notti, B.S. Mr. Notti, who was born in Alaska, received in 1969, the first honorary doctorate awarded an Athabascan Indian. Owner and operator of an electronics systems firm, he graduated from the Northrop Institute of Technology. Active in native affairs, he is coordinator for the Alaska State Community Action Program.

Andrew Acoya, M.Arch. (1943-). Probably the first Pueblo Indian graduate of M.I.T., Mr. Acoya, who was born in New Mexico, has worked in the area of low-income housing in both the United States and Colombia.

George W. Waller, B.S. (1947-). Mr. Waller, a Seneca-Cherokee from Illinois and cum laude graduate of CalTech, specializes in astrophysics.

Fred M. Bray, M.S. (1944-). Born in San Diego, California, Mr. Bray, a Choctaw, graduated from the University of Oklahoma. The recipient of many scholarships and awards, he was elected to several honor societies and named the outstanding senior in the College of Engineering. Now an officer in the Air Force, he is active in and has held several offices in the American Institute of Aeronautics and Astronautics and the Society of Automotive Engineers.

Kevan Green (1943-). Mr. Green, a Mohawk-Onondaga who studied chemical engineering at Cornell University, is the co-founder and president of Polymer Applications Co. of Tonawanda, N. Y., a chemical and resin manufacturing concern. In July of 1977 he was named New York's Small Businessman of the Year.

In their "Engineering Career Opportunities", Rockwell International, Space Division identifies the following Indian employees who are working in scientific or technical fields at their Downey, California plant:

William St. Clair (Southern Cheyenne/Northern Arapaho from Arizona), associate quality engineer for the Space Shuttle Program who graduated from Haskell Indian Junior College.

Curtis Grinnel (Hidatsa from North Dakota). Because he never expected to attend college, Mr. Grinnel dropped out of high school. At this point in his life he met his future wife who "let me know anything can be done if you really want to do it." Lacking basic math and engineering prep classes, he found his first year at college very difficult, and maintained only a 1.9 GPA. He persisted however, and attended Long Beach City College where he raised his grades and received an A.S. degree in architectural design. Now majoring in structural engineering at Cal State Fullerton, he combines school and work under a special Rockwell International program. Grinnel eventually hopes to have his own architectural firm and to employ and train Indians in that field. Interested in working with Indian students considering engineering careers, he did the basic write up for the *Engineering Opportunities Bulletin*. (See bibliography).

Arthur Ketcheshauno (Kickapoo from Oklahoma). Graduate of Haskell Indian Junior College who works with scientific and engineering data processing in the scientific computing center.

Glenda Ahhaitty (Cherokee from Texas) prepares computer reports for test data laboratory (including the formulation of programs used to validate the space shuttle testing requirements) and is studying to become a computer programmer. Currently the company's American Indian ethnic representative, she is also responsible for interfacing with the native American community.

Don Dillehunt, Ph.D. (White Mountain Apache from Arizona) received a B.S.E.E. and his Ph.D. in electrical engineering from Arizona State University. Is presently supervisor for the Space Shuttle on-board computer program requirements, integration, and evaluation.

Rena Beyale (Navajo from Arizona), senior drafting technician studying to become a design engineer.

Robert Russell (Crow from Montana), associate design engineer, Packaging and Transportability for the Space Shuttle and B-1 programs.

Charlie Toledo (Jemez Pueblo), engineering associate in design group.

CHEMISTRY, BIOLOGY, BOTANY, AGRONOMY, ENVIRONMENTAL SCIENCE, AND FORESTRY

Bahe Billy, Ph.D. (1937-). Dr. Billy, a Navajo who worked as a farmhand during his student days, received his B.S. in agronomy (technical soils) from Utah State University; his M.S. in agricultural chemistry and soils; and his Ph.D. in agricultural chemistry and soils (soil fertility—range management) from the University of Arizona, Tucson. (His master's thesis was on "The Effect of Water Quality on Calgon Soil and Crop Production"; his Ph.D. dissertation on "The Effects of the Rates and Dates of Commercial Fertilizers on Four Grassland Sites".) Now director of technical services for Navajo Agricultural Products Industry in Farmington, New Mexico, (and a part-time teacher at San Juan College), he has held such positions as director of Manpower Development for the Navajo Nation Irrigation Project, and assistant professor of agricultural economics at Brigham Young University (where he received the Spencer W. Kimball Lamanite Leadership Award in 1970). He has also been twice-honored for his achievements by the Navajo Tribal Education Committee. Widely-published in the fields of soil treatment, irrigation, and a variety of Navajo concerns, he was the first Navajo to earn a Ph.D. He is especially interested in using his knowledge and abilities to help his people.

Walton M. Youngblood, M.S. (1929-). A Pueblo Indian who lives in the Santa Clara Pueblo of Espanola, New Mexico, Mr. Youngblood is the regional services director for the Health and Social Services Department of New Mexico's Environmental Protection Agency, a position which includes responsibility for 84 regional personnel and 35 personnel for community services. Starting his college education as a pre-veterinary medicine major at Texas A & M, he also attended Cal Poly (majoring in dairy manufacturing) for a year before joining the Army where he spent 21 years. During his Army years he returned to Cal Poly and earned a B.S. in food processing. Following his retirement from the service, he joined the EPA and returned to school, picking up his M.S. in environmental science from the University of Oklahoma in 1971. A series of ever-more responsible positions--sanitarian, environmental scientist (solid waste, environmental chemicals), program manager, environmental manager and chief of special projects--led to his present post. He is now a candidate for a master of management

degree in the University of New Mexico's Executive Program. The honors and awards he has received include the Army Commendation Medal with Oak Leaf Cluster, Bronze Star Medal, and recognition as the Outstanding Agriculture Graduate at Cal Poly. His activities include participation in the University of Oklahoma School of Engineering's FATE Program for attracting Indian students into engineering and environmental science and speaking at a NASA program for minority students.

Don Colesto Ahshapanek, Ph.D. An instructor of biological sciences at Haskell Indian Junior College in Lawrence, Kansas, Don Ahshapanek earned his Ph.D. in botany at the University of Oklahoma (Dissertation--"Ecological Studies on Plant Inhibition by *Solanum rostratum*"). A Delaware/Nanticoke from Anadarko, Oklahoma, he has also taught courses on contemporary and historical Indian life, ecology, and wilderness biology and has worked in special programs designed to encourage Indian students interested in the medical and health professions. Since June of 1976, he has been program director of the National Institute of Health's Minority Biomedical Support Program at Haskell, a motivational program for which the college was awarded a one-year (renewable for two years) grant of $106,000. As a project director, he has three Indian students working under his direction in the area of systemics and the physiology of phosphate-dissolving microorganisms in grasslands. Married and the father of three, he lists philately and tennis as his hobbies.

Jack R. Ridley, Ph.D. (1933-). Associate professor of Native American Affairs and director of the Center for Native American Development at the University of Idaho, crop physiologist Jack Ridley (B.S. in agricultural education with a math minor; M.S. in agronomy and agricultural economics; Ph.D. in botany: plant physiology and biochemistry), now uses his knowledge in research and teaching. His expertise includes Native American affairs as they relate to tribal land resources, economic production, the planning and development of land, and middle management expertise of Native American students and tribal government leaders. He also developed this country's first Indian-operated graduate program. An alumnus of the University of Nevada and U.C. Davis, he has worked in the areas of animal grazing and forage economics, and economic crop/seed profunction and physiology, continues research, and teaching upper division courses.

Clifton Poodry, Ph.D. (1943-). Born in Buffalo, New York, Dr. Poodry grew up on the Tonawanda Seneca Indian Reservation near Akron, New York, where most of his family still live. An assistant professor of biology at U.C. Santa Cruz, he took his B.A. and M.A. in biology at S.U.N.Y. in Buffalo; his Ph.D. at Case Western Reserve University in Cleveland, Ohio; and was a postdoctoral fellow with Dr. David T. Suzuki at the University of British Columbia's Department of Zoology. His research interests lie in the general area of developmental genetics and cell biology and, more specifically, center around problems in morphogenesis and pattern formation. Widely-published and the recipient of many research grants (the latest being two N.I.H. grants; one as co-principal in the U.C. Santa Cruz Minority Biomedical Support Program which offers graduate career opportunities in Biomedical Research to minority students--see Appendix A), he teaches courses in developmental biology, developmental genetics, introductory biology, science and society and "Bugs: An Introduction to Insect Physiology and Development." A member of the American Society of Zoologists, the Genetics Society of America, and Sigma Xi, he has served as a National

Advisory Council panel member to evaluate applications for the National Science Foundation Graduate Fellowship Program; as a member of the University of California Cancer Research Coordinating Committee; and an Advisory Committee member of the AAAS Minority Science Education Bibliography project.

Frank C. Dukepoo, Ph.D. (1943-). A geneticist with a special interest in aging, especially among minority people, and the first member of the Hopi Indian tribe to receive a Ph.D., Frank Dukepoo is an assistant professor (general biology, human heredity and genetics) at San Diego State University. Born in Parker, Arizona on the Mojave Indian Reservation, he received his B.S. (biology), M.S. (zoology) and Ph.D. (zoology with genetic emphasis) from Arizona State University at Tempe. Starting as a research analyst (insecticides and pest control) with the U.S. Department of Agriculture in Phoenix, he moved into teaching (in several Arizona schools), a career that brought him to S.D.S.U. in 1973. His research--in such areas as minority aging, albinism, and the investigation of maternal effects and tumor formation in D. Melanogaster and "Alcohol Sensitivity, Metabolism, and Ethnic Background"--has brought him a number of grants (among them a Ford Foundation Advanced Study Fellowship) and led to both publication and the presentation of papers at many professional meetings. A consultant to several groups, including the N.S.F. (site visiting team member, Minority Sciences Programs), the AAAS (National Advisory Panel member on Native Americans in Science), the BIA (Secondary Science Programs and Open Air Classroom Teaching), the Kumeyaay Tribal Council, San Diego, the San Diego American Indian Health Clinic, and the National Indian Task Force on Aging, he is also a member of several professional and Indian societies and has been listed in *American Men and Women in Science*, *American Indians of Today* and *The National Native American Directory*.

Agnes N. Stroud (Schmink), Ph.D. (1922-). A member of the Tewa Tribe, Santa Clara Indian Pueblo (New Mexico), Dr. Stroud was born in Albuquerque, the daughter of a full-blooded Santa Clara Indian father and a Caucasian mother, both of whom taught at the Santa Fe Indian School and the Albuquerque Indian School. A graduate of the University of New Mexico (B.S. in biology) and the University of Chicago (Ph.D. in biology-zoology, biological science--thesis, "Effects of X-Irradiation on DNA Synthesis in Regenerating Liver"), she is a radiobiologist for the Mammalian Biology Group of the Los Alamos Scientific Laboratory. (Past positions included that of director of the Department of Tissue Culture at the Pasadena Foundation for Medical Research in California and senior biologist for the Image Processing Group at Pasadena's Jet Propulsion Laboratory.) She has been involved in ionizing radiation biology research for the past 32 years, with emphasis on how ionizing radiation affects the living cell. Among her many published works are--"The Effects of Continuous Irradiation by Tritium on Cells Cultivated *in Vitro*," "Utilization of Thymidine as an Indicator of Drug Effects Upon Cancer Cells," "The Combination of Microscopes and Computers for the Analysis of Chromosomes," and "Reproductive Integrity of Cells After Ultra-Violet Laser Irradiation."

A member of a number of professional associations and societies (involving cancer research, cell biology, microbiology, genetics, radiation research, tissue culture, etc.), she has held office in many and is listed in *Who's Who in American Men in Science*, *Who's Who in American Women* and *Who's Who in Atoms*. Among her honors are the New York Academy of Science's A. Cressy Morrison Prize in natural science, a diploma of honor in cytology from the first Pan

American Cancer Cytology Congress, a NASA certificate of recognition for the creative development of technology, and membership in Sigma Xi and Sigma Delta Epsilon. A frequent symposium speaker, she has presented many scientific papers both in the United States and England. Married and the mother of one adult daughter, she counts stamps, art, lapidary work, Indian jewelry making, tennis, and golf among her hobbies.

Robert Dominic, Sr., B.S. (1913-). Formerly a metallurgist and forestry technician, Mr. Dominic, an Ottawa from Michigan who graduated from Central Michigan University, has since spent his time fighting for Indian rights, among them the recovery of government moneys through the prosecution of treaty claims.

Robert E. Dominic, M.S. (1941-). The son of Robert Dominic, Sr. (see above), he is an instructor of chemistry at Alpena Community College.

Richard French, B.S. (1939-). A Yakima from Toppenish, Washington, Mr. French is probably the only Indian with a degree in forest management. A graduate of Yakima Valley College and Washington State University, he is at present directing the cutting back of timber on the Ft. Apache Reservation forest (tribal-owned) and has published a paper reporting on the effects of logging on the fishery resources of the west.

Robert G. Raymond, M.P.H. (1931-). A Dakota-Oglala from South Dakota, Mr. Raymond is a graduate of South Dakota State University and the University of Minnesota. He is with the Indian Health Service at Billings, Montana, and was the first Indian sanitary engineer in the Public Health Service.

SCIENCE EDUCATION

Albert J. Snow, D.Ed. (1935-). A Mohawk of the Iroquois, Dr. Snow is the science chairman for grades 7-12 of the Eastchester (New York) Public Schools. Born in North Tonawanda, New York, he attended high school in Brooklyn before getting his B.S. (chemistry) at St. John's University in Jamaica, New York; an M.S. (science education) at C.W. Post College in Greenvale, New York; an M.A. (chemistry) at Bowling Green State University in Ohio; and his D.Ed. at the University of Maryland. Among his special professional interests are the training of Indian teachers and development of Indian-oriented curricula and teaching methods; the assessment of Navajo science and math education; and in-service teacher training with an emphasis on the practical application of Piaget's theories to science education. A member of several education associations and recipient of three federal grants, he has served as a book reviewer for the NSTA Science Teaching Materials Review Committee and has published articles on ethnoscience.

Don Clark (1922-). Mr. Clark, a high school science teacher in Sebastopol, California, was born in Frazee, Minnesota. (Because record-keeping was not considered especially essential then and the country was still relatively wild and informal, he is finding his current efforts to trace his ancestry through his father's people, the Ojibwas, most challenging.) After graduating from high school in Ohio, he spent three years as an aircraft mechanic during World War II then, thanks to the G.I. Bill, found himself studying wildlife biology and journalism at Michigan State. Although teaching comes first, he retains an intense interest in writing and has had one article published in *Western*

Horseman Magazine. His future plans include working on a degree in Native American Studies at Berkeley over the next couple of years, with the goal of rounding-out his career by becoming more involved in Indian education. Founder and sponsor of the Native American Club at his school, he enjoys working with and encouraging Indian youngsters and has helped start a scholarship program that has made it possible for all of the school's Indian students (mostly Pomo) who want to go on to college to receive some financial aid.

Michael R. Crawford (1943-). Now Maine's deputy commissioner of Indian Affairs and economic consultant for the Penobscot Indian Corporation, Mr. Crawford was formerly a math and science teacher in Bangor. Born on the Penobscot Indian Reservation on Indian Island, Old Town, Maine, he is a graduate of Washington State College and the University of Maine.

Major General Lloyd R. Moses (1904-). A Rosebud Sioux from South Dakota, General Moses studied and taught chemistry at Sioux Falls College before going into the Army. Once Senior United Nations Commander, he was, at the time of his retirement, the Deputy Commanding General of the Fifth Army.

WEATHER FORECASTING

First Lt. Marcia Ann Biddleman (1945-). Awarded the first Woman Officer Basic Course Leadership Award given by the Marines, Lt. Biddleman is also their only female weather forecaster. A Seneca from Pennsylvania, she received her training as an aerographer while in the military and has an avid interest in studying Indian culture.

AUDIOLOGY, OTOLARYNGOLOGY

Joe Sando, M.A. (1923-). A graduate of the University of New Mexico and Vanderbilt University, Mr. Sando is very active in Indian affairs and has written heavily in the areas of audiology (his major field), Indian problems, and history. A recent publication, *Pueblo Indian Biographies*, details the life stories of some of the most successful of his people. As an audiologist and speech pathologist in Albuquerque, he had the job of examining many future astronauts. A football player in his college days, he started the annual All-Indian Track Meet at the Jemez Pueblo, an event that often leads to track scholarships for the participants. One of nine American Indians sent to New Zealand to study the Maoris, he is also interested in verifying the historical accuracy of the Pueblo Indians' legends.

Evelyn Yellow Robe, Ph.D. A Fulbright Scholar who studied the physiology of the larynx at the Faculte de Medecine in Paris, Dr. Yellow Robe, a Rosebud Sioux from South Dakota is a graduate of Mt. Holyoke College (magna cum laude) and Northwestern University. A specialist in audiology and speech disorders, she has taught at Vassar and Northwestern's Medical School and has devoted much time to recording the Dakota language.

ARCHEOLOGY

Edmund J. Ladd, M.A. The first Zuni to earn a college degree, Mr. Ladd, an archeologist with the National Park Service in Hawaii, has a special interest in Pacific and Southwestern archeology and community planning. Born in California, he is a graduate of the University of New Mexico.

MATHEMATICS

John Kaskaske, B.S. A Kickapoo and Potawatomi from Oklahoma, Mr. Kaskaske, an orbital computations engineer for the Operational Orbit Support Branch of NASA's Goddard Space Flight Center in Greenbelt, Maryland, is currently assigned to the International Sun, Earth Explorer program. The recipient of a B.S. in math and physics from Central State College in Edmund, Oklahoma, he has also worked for the Analytical Loggoing Corporation in Oklahoma City and the Aeronautical Chart and Information Center in St. Louis.

Addison Jump, M.S. Born in Pawhuska, Oklahoma, Mr. Jump, an Osage, received his B.S. and M.S. in mathematics from Oklahoma State University. Currently an instructor of math at Haskell Indian Junior College, he is also studying educational psychology at Kansas University and working on a project aimed at increasing scholastic aptitude.

ANTHROPOLOGY

Ishi (Circa 1862-1916). Called the last Stone Age man in America, Ishi was, quite literally, a walking textbook of anthropology and history. Discovered, confused and starving, on the outskirts of Oroville, California on August 29, 1911, he created quite a stir when it was found that he spoke an "unknown" language. Communication with him remained impossible until T. T. Waterman, a young anthropologist from the University of California, conceived the idea that Ishi might be a Yana (a near-extinct tribe) or even a Yahi (the southernmost branch of the Yanas, believed extinct). Working his way unsuccessfully through a list of known Yana words, Waterman was becoming discouraged when Ishi reacted to one--"Siwini" (yellow pine). Months of work later, a workable vocabulary emerged and Waterman learned that Ishi was indeed a Yahi, the only living member of the tribe. Working with Ishi at U.C. San Francisco's Department of Anthropology, Waterman was able to study a "dead" language and culture and Ishi, who adapted well to the whites' world, made many friends among the school's scientists. (Working as a janitor at the school's Museum of Anthropology, Ishi learned the skills needed for his new life and enjoyed helping the professors study his language). Among the things Waterman learned was Ishi's name, which means "man" (not his personal name as to tell that would have meant the loss of his soul), and the tragic history of his people who had been tracked down and exterminated by settlers. A few, including eight-year old Ishi, escaped into the treacherous hill country where all but Ishi died during the next 40 years. Taking his new friends to upper Mill Creek, Ishi showed them where and how he had lived--harpooning salmon, using ropes and nets made of animal sinews and milkweed fibers to trap and snare small animals, shooting deer with bows and arrows, drying meat on racks hidden by chapparal and harvesting acorns to grind into meal. So that no footprints would reveal their presence, they traveled on the boulders of Mill Creek and along the face of sheer rock walls

(scaling them with milkweed fiber ropes), and crawled through the chapparal. (An annual trip up Mt. Lassen let them escape the hottest part of summer.) They made baskets and stone mortars and pestles, shaped obsidian into arrowheads and used bow drills to make fire.

Ishi, who had lived on his own for three years after the last of the others died, contracted tuberculosis in San Francisco and died in 1916. Waterman arranged a ritual cremation for him and had his ashes placed in a Hopi jar at Mt. Olivet Cemetery.

Edward Pasqual Dozier, Ph.D. (1916-1971). The first American Indian to earn a Ph.D., Dr. Dozier was the son of a white man who came to the Santa Clara Pueblo as a teacher and married a former student. His university career, at the University of New Mexico and UCLA, was frequently interrupted--by the need to work and by his Air Force service--but he stayed with it until in 1952 he received his doctorate, an accomplishment heralded by *Time Magazine*. During his years at UCLA he completed research which identified the Hanos of Arizona as descendants of the Southern Tewas, who left their New Mexico home in the days of Spanish oppression. Postdoctoral studies and fellowships occupied several more years, during which time he engaged in research among the Rio Grande Pueblos and the Klingas of the Philippines. He then became a professor of anthropology at the University of Arizona, Tucson, a position he held until his death. His book, *The Pueblo Indians of North America*, is one of the best known and most informative available on the Pueblo society, ancient, and present. Twice a fellow at the Center for Advanced Study in the Behavioral Sciences at Stanford, he also studied the Bay Area's urbanized Indians. Two other books and many scholarly articles resulted from his research; he was also active in many professional and Indian groups.

Fredrick Dockstader, Ph.D. Dr. Dockstader, a Navajo and director of the Museum of the American Indian, is well-known as an anthropologist, author, artist, educator, and silversmith and has written many books and articles, among them some especially notable ones on Indian art.

Ella Deloria, B.S. A graduate of Columbia University, Ms. Deloria is recognized as the leading authority of the culture of her people, the Dakota-Yanktons. Many honors have come her way, among them the opportunity to address the American Philosophical Society. Extensively published, she specializes in anthropology, linguistics, and ethnology.

Beatrice Medicine, Ph.D. (1924-). Acting director of Native American Studies and assistant professor of anthropology at San Francisco State College, Dr. Medicine, a Dakota-Standing Rock from South Dakota, is a graduate of South Dakota State University and Michigan State University. A frequent writer on Indian subjects, she is interested in the development of Indian leadership and the establishment of urban Indian centers. The recipient of many honors and awards, she shares many of the traditional practices of her tribe and is raising her son in the old ways.

Wilfred C. Wasson (1924-). Mr. Wasson is director of Indian Studies at the College of Ethnic Studies, Western Washington State College and the University of Oregon.

Christine Morris, M.S. (1932-). Ms. Morris, a Blackfeet Indian from Wyoming, graduated from the University of Wyoming and Montana State University and is a teacher of sociology and anthropology.

Gladys Tantaquidgeon (1899-). A Mohegan from Connecticut, Ms. Tantaquidgeon is a descendant of Uncas (see *Last of the Mohicans*) and one of the first Indian anthropologists. She is at present curator of the Tantaquidgeon Indian Museum.

Alfonso Ortiz, Ph.D. (1939-). A graduate of the University of New Mexico, Arizona State University, and the University of Chicago, Dr. Ortiz, a Pueblo Indian, is presently studying the Pueblo society in which he was raised. Among his special interests are the American Indian's concepts of space and time and the relationships found in dual societies--those split into two opposing units which, nevertheless, perform services for each other.

D'Arcy McNickle (1904-). Professor of anthropology at the University of Saskatchewan and the author of several books about Indians, Mr. McNickle, a Flathead Indian from Montana, received his education at the University of Montana, Oxford University, and Grenoble University. A fellow of both the American Anthropological Association and the Society for Applied Anthropology, he formerly worked for the BIA as director of Tribal Relations and executive director of American Indian Development.

PSYCHOLOGY

Marigold Linton, Ph.D. The following statement, dated May, 1977, tells Dr. Linton's story in her own words:

> I was born on the Morongo Reservation (near Banning, California) where the family of my father, a Cahuilla-Cupeno, have lived since the turn-of-the-century. Before that the family had lived on Warner's Ranch (Warner's Hot Springs). My grandmother's grandfather, Antonio Garra, led the Garra insurrection and, as a result, was executed in 1852 by the Spanish authorities at the foot of Broadway in San Diego.
>
> Although I spent most of my time in high school worrying about my class work, I also was first singles and later first doubles on a successful girls' tennis team. I attended the University of California at Riverside--in part because I was too frightened to go to Los Angeles, where I had been offered a scholarship at the University of Southern California. Probably the question I'm asked most often is how and why does one leave a reservation and become successful as a scientist. I'm not sure that anyone really knows the answer for themself, but my mother's insistence that one never be satisfied with easy victories and that one continue to work to improve oneself throughout one's life were very important. I suspect that having a very high energy level is also essential.
>
> I received my Ph.D. at UCLA in 1964 and encountered my first obstacles to success, not because I was an Indian but because I was a woman and universities were at that time reluctant to hire women. I worked for a year with children who had attempted to commit suicide, trying to learn why they had done so, and how such attempts might be prevented. But this was not my special area and very shortly I went to San Diego where I taught for 10 years at San Diego State, moving in rank from assistant to full professor. But San Diego isn't

primarily a research institution and in 1974 I moved to the University of Utah in Salt Lake City. Here I continue to pursue my research on long-term memory--trying to understand what kinds of things we remember, why, and for how long. But during the years at Utah I've become very much involved with the problems of Indian education and presently am working to set up programs for gifted Indian children at a variety of sites around the United States. I serve as a technical consultant to the Office of Indian Education in Washington, D.C., as an adviser to the National Academy of Sciences, to the National Institute of Mental Health and other federal organizations. One of the roles I particularly enjoy is that of providing technical training to the Indian people who are responsible for managing the special education programs around the country.

I especially enjoy playing tennis and racquetball, and I try to play an hour or two a day, year around. I am still a very excellent player and am much more likely to lose to a cagey old man than to an energetic young student. I enjoy gourmet cooking and have enjoyed cooking dishes from every cuisine in the world. I greatly enjoy teaching and appear to be particularly effective in training students on problems of methodology. I teach classes on memory, on research methods, on intelligence and developmental psychology.

My father and his siblings still live on Monongo reservation. My older brother lives and works a few miles away. My younger brother, who is a career enlistee in the Air Force, plans to return to the reservation when he retires. Although I return to visit my family there regularly, my affiliation with a distant university assures that it will be many years before I can consider returning there to live.

Now a professor of psychology at the University of Utah, Dr. Linton is a contributing editor to the *Journal of California Anthropology* and is the author of two books (on statistics and the preparation of journal articles) and an impressive array of articles, papers, and reports. Listed in *American Men and Women of Science, Who's Who in American Women, Who's Who in the West, Contemporary Authors* and the *Dictionary of International Biography*, she also has to her credit an almost staggering collection of awards, honors, activities, and memberships.

Carolyn L. Attneave, Ph.D. (1920-). Professor of psychology at the University of Washington and director of their American Indian Studies program, Dr. Attneave, who was born in El Paso, Texas, is an expert in family therapy and various aspects of childhood and Indian psychology. Listed in *Who's Who in American Women* and the *International Dictionary of Biography*, she holds four degrees (a B.A. in English, speech and art, and one in elementary education from Chico State College in California; an M.A. in elementary education and administration; and a Ph.D. in counseling psychology from Stanford), is a diplomat of the American Board of Professional Psychologists and a member of or consultant to many other community, professional, government, and Indian groups. A widely published writer, she was a contributing author of *The Book of Family Therapy* and was a recipient of the Book of the Year Award for books in behavioral and social sciences. A brief sampling of her listed titles gives some idea of her research interests:

A Return to Hippocratic Concepts
Uneasy Relationship: Medicine Men and Psychiatrists in the Indian Health Service
Experience With Behavior Modification as a Tool in Family Therapy
Social Networks in Time and Space
Behavior Problems of Children as Evaluated by Teachers, Parents and Caseworkers

Kirmach Natani, Ph.D. The career of Dr. Natani, who is part Navajo, has often been affected by what he describes as "serendipitous accidents." Forced by financial problems to leave the University of Nevada where he was studying electrical engineering, he was able, thanks to his chemistry minor, to get a laboratory technician's job with the Segré/Chamberlain group (recipients of the Nobel Prize for discovering the anti-proton) at U.C. Berkeley's Lawrence Radiation Laboratory. Upon leaving Lawrence (where, by then, he was a computer programmer), he joined the Peace Corps and was sent to Thailand as a community development specialist. While vacationing in Nepal during that time, a chance meeting with a psychiatrist led to yet another job as a research technician in a sleep study conducted at the Amundsen-Scott South Pole station in Antarctica. Data collected there on "Observations of Mood and Performance in a Small Group of Men During Eight Months of Isolated Duty in Antarctica" became the basis of his master's thesis at the University of Oklahoma (undergraduate requirements having been waived). He then transferred to the Medical School campus and, in 1977, was awarded a Ph.D. in biological psychology (thesis--"Laterality Effects in a Tachistoscopic Optional Shift Task in Young Adults"). In the fall of 1977, he will begin tenure as a National Research Council Resident Research Associate in Neuropsychology at the U.S. Air Force School of Aerospace Medicine in San Antonio, Texas (studying, primarily, human cerebral lateralization). A number of honors and awards have come his way, among them NSF grants to attend the first International Congress of Sleep Psychophysiology (Belgium); the first Scientific Committee for Antarctic Research Symposium on Human Biology and Medicine in Antarctica (England); a Roche Neuroscience Award; a Rice Institute Scholarship to attend a resident group relations conference in Minnesota; a National Academy of Science exchange visit to the U.S.S.R.; membership in Sigma Xi; and a listing in *Who's Who in the South and Southwest*. Widely-published and a member of many professional organizations, his current research activities include working on "Lateralized Aspects of Cognitive Functioning" and "Alteration of Sleep-Waking Biorhythms in Cats by Psycho-active Drugs and an Air-Fluidized Bed Environment."

Robert A. Ryan (Mato Topa), Ph.D. (1942-). In 1973, in a special ceremony at the annual gathering of the Cheyenne River Sioux, Dr. Ryan was given his great-grandfather's name, Mato Topa (Four Bear), an honor accorded him upon receipt of his Ph.D. and for his work with his people. Acting director of the White Cloud Center (National Center for American Indian and Alaskan Native Mental Health Research and Development) in Portland, Oregon and an assistant professor of medical psychology at the University's Health Service Center, he holds a B.S. in zoology from South Dakota State University; an M.A. in counseling; and a Ph.D. in counseling psychology from the University of South Dakota. Prior to joining the Center, he was Coordinator of Indian Education and Assistant Professor of Counseling at the University of South Dakota in Vermillion, and had earlier been director of Project Head Start on his home reservation. All of his many research papers and articles deal with the American Indian and he has served as consultant on many Indian human relations and mental health

health programs. Married, with four children, he is involved in many cultural, community, and professional activities.

Loye M. Johnson Ryan, Ed.D. (1941-). Like her husband (see above entry), Dr. Loye Ryan is an enrolled member of the Cheyenne River Sioux Tribe. A graduate of Moorhead State University in Minnesota (B.A. in sociology, M.S. in counseling and guidance), she took her doctorate (in counseling psychology) at the University of South Dakota. A Ford Foundation Fellowship recipient, her master's thesis--"Reasons for American Indian Students Dropping Out of a Minnesota High School"--and Ph.D. dissertation--"A Study of Personality Traits and Values of American Indian and Non-American Indian Counselors Trained at the University of South Dakota"--are indicative of her major research interests. Now a research associate for the American Indian Mental Health Program of the University of Washington's Department of Psychology, she has also worked as an American Indian student advisor/counselor and as a consultant for many programs designed to aid her people.

Wayne H. Evans, Ed.D. (1938-). A former grade school teacher and principal, high school teacher, and guidance counselor, Dr. Evans, who was named "Outstanding Young Man of America", also helped establish both a Head Start Program and a neighborhood Youth Corps for the Indian residents of Niobrara, Nebraska. A native of South Dakota and member of the Rosebud Sioux Tribe, he holds a B.S. in elementary education and art (with a history minor) from Black Hills State College in Spearfish, South Dakota and a M.Ed. and Ed.D. in educational psychology and guidance from the University of South Dakota at Vermillion. Now coordinator of the American Indian Programs and Director of American Indian Student Service at the University, he is also Title IV Parent Committee Chairperson for the Vermillion Public Schools. An instructor of modern Indian psychology, pupil personnel services, cultural aspects of counseling, and a workshop in Indian education, he is actively involved in a number of cultural and educational organizations and is conducting research on the value orientation of American Indian college students.

Terry Denny, Ed.D. (1931-). Born in Detroit, Michigan, Dr. Denny worked as a laborer from the time he was 15. During his years of Army service (in the U.S. and Germany) he also earned a B.A. in political science and Russian language from Wayne State University in Detroit. This was followed by an M.A. in child development from the University of Michigan and an Ed.D. in educational psychology and elementary education from the University of Illinois. Moving from instructor to associate professor of psychology and educational psychology at Purdue University, he taught child and adolescent development and educational psychology at both the undergraduate and graduate level and created the school's first undergraduate research program in education. During those years he also directed the research department in the Notre Dame-Carnegie National Study of Catholic Education. Next came the position of research and evaluation director for the Educational Products Information Exchange Institute of New York. This was followed by his present post as evaluation specialist and professor of education at the University of Illinois' Urbana-Champaign campus, where he is a member of the Committee for Culture and Cognition. His many research and writing credits are primarily in the field of early childhood education with an emphasis on reading concepts and approaches; the effects of anxiety, and the Montessori system. Other studies involve such subjects as classroom research, educational evaluation, the performance of Catholic students in public schools, Russian studies, and instructional TV.

Leo David Jacobs (Ph.D. Candidate) (1943-). Born on the Mohawk Reservation in Hogansburg, New York, Mr. Jacobs attended Paul Smith's College, the State University College of New York, and the University of Utah, where he is an instructor in the department of psychology and conducts research in psychology, attribution, cross-cultural leadership, program development and evaluation. A sub-chief of the Akwesasne Mohawk Tribal Council (from 1973-1975) and project director for the tribe's cable TV project, he has been heavily involved in a variety of minority and cross-cultural programs, both in New York and Utah, and has presented addresses on "Anglo Perceptions of Native American Role Behavior," "Iroquoian Philosophy and Psychological Concepts," "Cross-Cultural Attribution and Iroquoian Philosophy," "Political Philosophy of the Iroquois Confederacy," etc.

Joe Jimenez, B.S. Executive dean of the Career Center, a vocational-technical training program and school on the Gila River Reservation, Mr. Jimenez, a clinical psychologist, is working to help the area's Pima and Maricopa Indians. A Pueblo-Nambe Indian, he is a graduate of New Mexico Highlands University, Brigham Young University, and the Esalen Institutes.

Phil Terry Newkumet, M.S. (1945-). An honor graduate of the University of Oklahoma, Mr. Newkumet is a Caddo from Savannah, Georgia.

DENTISTRY

George Blue Spruce, Jr., DDS, M.P.H. (1931-). The only full-blooded American Indian dentist, Dr. Blue Spruce (See entry for his brother, Dr. Beryl Blue Spruce, Medicine), a Pueblo Indian born in Santa Fe, New Mexico, spent his younger years at the Santa Fe Indian School where his father taught and his mother worked as a cook. Valedictorian of his high school class, he, with the financial help of the New Mexico Elks Association, attended Creighton University in Omaha, Nebraska (receiving his DDS in 1956). Further study at the California School of Public Health in Berkeley and the Federal Executive Institute in Charlottesville, Virginia, brought him a Master of Public Health degree and an Executive Management certificate. Two years as a Navy dentist were followed by the establishment of a private practice in Santa Fe and, in 1958, he entered the U.S. Public Health Service, working as a dental officer at several Indian reservations. Other positions--among them deputy chief of the PHS Outpatient Clinic in New York City and chief dental officer at the U.S. Merchant Marine Academy followed. He developed a mobile clinic used for Indian children in Nevada and, as a consultant in dental health for the World Health Organization, spent two years in South America, where he developed simplified techniques and equipment to be used in primitive areas (a manual he wrote describing this equipment has been widely circulated in Pan American countries). A number of other government and administrative positions followed (including director of the Office of Native American Programs) and in 1976 he was appointed chairman of the Department of Health, Education and Welfare's Intra-Departmental Council on Indian Affairs.

Long-interested in recruiting disadvantaged and minority students into health careers, he is a member of several organizations working toward this goal and has published several articles in this area. In 1975 he received the Outstanding American Indian Achievement Award for his work. Now a resident of Reston, Virginia, he is an avid tennis player (captained his college team) and is a member of the U.S. and Mid-Atlantic Lawn Tennis Associations.

Ted W. Key, DDS (1918-). A Choctaw from Oklahoma, Dr. Key was raised in an orphanage and is a graduate of St. Louis University Dental School. A variety of jobs and football scholarships and a Navy program helped him along and today he practices in St. Louis, is a commander in the Naval Reserve and has held several offices in the dental societies to which he belongs.

Kristine Rayola Harvey (Dah-Nez-Tach). A full-blooded Apache from the White Mountain Reservation in Arizona, Ms. Harvey is a dentistry student at Brigham Young University. "Miss Indian America, 1976," she is a graduate of a professional modeling school and enjoys participating in amateur rodeos. Upon completion of her studies, she plans to go into practice on the reservation at White River, Arizona where her father works for the tribal forestry service and her mother is active in a senior citizens' advocates group.

MEDICINE, PHYSICIANS/MEDICAL STUDENTS

Carlos Montezuma, M.D. (1867-1923). In 1871 Wasajah ("Beckoning"), an Arizona Apache, was abducted by Pima warriors and sold, for the price of a horse to Charles Gentile, a white prospector. Gentile sent his ward to school in Chicago, and Wasajah, who took the name Carlos Montezuma, later graduated from the University of Illinois and the Chicago Medical School. After establishing a private practice and teaching for a number of years at the Medical School (and at others in the area), he left to take his medical skills to Indian posts throughout the nation. Active in seeking white support for the Indians, he devoted much time and effort to helping his people and encouraging pride in themselves and their culture.

L. Rosa Minoka Hill, M.D. Another early medical success story was that of L. Rosa Minoka Hill, a New York Mohawk. The first woman of her race to become a physician, Dr. Hill was widely known and respected for her humanitarian acts.

Beryl Blue Spruce, M.D., M.P.H. (1934-1973). The story of Beryl Blue Spruce, the first Pueblo Indian to become a physician, is a particularly interesting and dramatic one. Born in Santa Fe, New Mexico to George Blue Spruce, Sr. (of the Laguna Pueblo), an instructor of wood-carving, cabinet making and drafting, and Juanita Cruz Blue Spruce (of The San Juan Pueblo), Beryl was first attracted to medicine during two long childhood years spent in a hospital. Although weakened by complications resulting from pneumonia (he was unable to take part in athletics), Beryl achieved an excellent high school record. In 1953 he entered Stanford University, but a year spent holding down three jobs had a disastrous effect on his grades. Advised by his counselor to seek some easier way to finance his education, he reluctantly returned home and, after getting some much needed rest, entered the University of New Mexico. After three years there, during which time he met his future wife and once again earned excellent grades, he re-applied to Stanford where, because he had to work, he remained an undergraduate for another three years. In 1960, following his graduation and months of often discouraging attempts to be accepted for training, he entered U.S.C.'s School of Medicine. His wife's salary as a nurse and a number of small scholarships made the next several years possible but the going was rough, especially in his senior year when his weakened lungs worsened and surgery to remove part of one became necessary. After interning at the Albert Einstein Medical Center in Philadelphia, he spent three years as a resident in obstetrics and gynecology at Pennsylvania Hospital and as a clinical instructor at the

at the University of Pennsylvania. Additional training at the University of Michigan led to a masters in public health and, soon, to a job as an instructor in the OB-GYN department of their medical school. He served as a consultant to the Student Health Services at both that university and Eastern Michigan University and was, at the same time, active in many Indian groups. His interest in organizing Indian physicians who could serve as role models and provide financial assistance to Indian students and would work to increase and upgrade the services provided his people, led eventually to his becoming the first president of the Association of American Indian Physicians (AAIP, Appendix C). His highly successful career ended abruptly and tragically when he died from a cold that his much-abused lung could not handle.

Frank Clarke. M.D. (1921-). Like Beryl Blue Spruce, Frank Clarke (a Walapai-Mission Indian from Blythe, California and the great-grandson of "Walapai Charlie," a famous war chief) suffered a childhood illness--a serious eye problem--that made him want to be a doctor. He worked at many jobs--field hand, janitor, lab technician, etc., served 12 years in the Navy, and borrowed heavily in order to get his education (at Los Angeles City College, UCLA, and St. Louis University School of Medicine.) The recipient of a John Hay Whitney Fellowship and numerous special awards and honors, he has served as chief of obstetrics, chief of medicine, chief of staff and president of the staff of Memorial Hospital in Exeter, California; physician-in-charge of the Woodlake Well Baby Clinic; and is a member of the Flying Physicians Association.

Joseph Daniel Mitchell, M.S. (1943-). A full-blooded Creek from Tahlequah, Oklahoma, Mr. Mitchell received his B.S. in biology from Northeastern Oklahoma State College, attended law school at Washington University and earned his M.S. in environmental biology at the University of Colorado. While working on his masters, he engaged in extensive research on the endangered greenback cutthroat trout of Colorado--the *S. c. stomias*. That research was aimed at "determining the life history and mechanics of displacement of the trout in order to obtain information pertinent to restoration projects now in progress." He has also had field experience with the Forest Service in the area of fire control and ecology. This rather new field of fire ecology, he explains, "is extremely broad and affects much wildlife as well as vegetation; hence, a knowledge of wildlife habits is vital to the understanding of fire ecology. With this in mind, I have concentrated my studies on the large mammals such as deer, elk, and moose and have become thoroughly familiar with their range, life histories, feeding habits, and space requirements. All things considered, I feel my educational background, combined with my field experience, has qualified me as one of the few American Indians with the capabilities of undertaking field research projects involving conservation and management of wildlife and natural resources."

The recipient of several scholarships and fellowships, he has also served as acting director of the American Indian EOP at the University of Colorado, Boulder, where he also headed an academic support unit for 70 American Indian students. Among his other jobs have been those of visiting instructor of general biology at the University of Colorado (taught a special class for minority students deficient in science skills); planetarium coordinator for the Pattonville School District in the St. Louis area of Missouri (coordinated programs and instructed classes, utilizing a planetarium and observatory, for 13 public schools); and was a teacher of high school math and science.

Albert Reifel, M.D. (1919-). Another physician whose experiences with illness affected his choice of careers is Albert Reifel, a Dakota-Brule from Parmalee, South Dakota. Tuberculosis was rampant among his people and he wanted to help them overcome this devastating disease, a disease he was later to contract and which, along with his financial problems, made getting an education quite a challenge. Now with the Sepulveda Veterans Hospital in California, Dr. Reifel, a specialist in internal medicine who worked his way through school and was forced to drop out twice to obtain medical treatment before fulfilling his dream of becoming a doctor, studied at the University of Minnesota and the University's medical school.

Charles B. Wilson, M.D. (1929-). Professor and chairman of the department of neurological surgery at the University of California, San Francisco, Dr. Wilson is part Cherokee and, like Dr. Thomas Mathewson, is a descendant of General Stand Watie. He has enduring interests in what he describes as the sad but colorful history of the Cherokee Nation, and in encouraging young American Indians to enter medicine. Born in Neosho, Missouri, he received his B.S. and M.D. from Tulane University, then completed a rotating internship and three residencies (one in pathology, two in neurosurgery). A number of university appointments followed--at Tulane, Louisiana State University, the University of Kentucky and, now, the University of California. A member of many medical, budgetary, editorial, study and advisory groups (cancer, trauma, brain tumor neurosurgery, chemotherapy, etc.), he is also consulting neurosurgeon for several California hospitals and medical centers, has been a visiting professor at a number of top schools and gives, at conferences throughout the United States, approximately 18 lectures a year (on neurosurgical techniques, brain tumors, chemotherapy, childhood cancers and trauma, etc.). Among his honors and awards are the Borden Undergraduate Research Award; the Isadore Dyer Scholarship Award (for standing first in his graduating medical class); the Best Teacher Award at Louisiana State; two awards--Outstanding Clinical Instructor and Outstanding Clinical Professor--at the University of Kentucky; and the Distinguished Alumnus Award of the Ochsner Foundation (where he took a neurosurgery residency).

Taylor McKenzie, M.D. Taylor McKenzie of Rehoboth, New Mexico, the grandson of a medicine man and the first full-blooded Navajo to become a physician, is a man with a dream--a dream his own efforts may soon make real. Out of his personal experiences, first as a child on the reservation and now as a doctor, was born a determination to not only bring much-needed medical help to his people but to someday make it possible for the Indian people to train their own physicians. The American Indian School of Medicine, now (1977) classified as a "developing" school, will be located in Shiprock, New Mexico and will have a program especially tailored to Indian needs (including courses in the "traditional" arts of the medicine man[19]) and a student body comprised of people (approximately 80% of them Indian) interested in working with reservation residents and more concerned with the rewards of service rather than with material success. Other efforts--to improve the living standards (adequate housing, electricity, plumbing, etc.), encourage Indian control of reservation schools, and promote new businesses for his people--are also part of Dr.

[19]Other aspects to be considered in establishing medical and health career training programs are cultural conflicts. Some tribes have taboos prohibiting the touching of the dead, for instance, which poses quite a problem in an anatomy class.

McKenzie's dreams and plans. A graduate of Wheaton College and Baylor University's School of Medicine, Dr. McKenzie took his five-year surgical residency in Pontiac, Michigan before returning to the Navajo Nation as a member of the Public Health Service's Commissioned Corps--and that Nation's only surgeon. His success came quickly, with such positions as chief of surgery at the Tuba City and Shiprock Indian Hospitals and his present jobs with the Navajo Health Authority and as president of the proposed School of Medicine. Married and the father of nine children, he plans to spend his life on the reservation, helping his people. For him, from a medical standpoint, the major challenges that he and other reservation doctors face include the stoic acceptance of disease (many Indians would rather suffer than face a several hours' ride over bumpy roads in the back of a pickup truck and more hours spent in the waiting room of an outpatient clinic.), hostility toward medical personnel who have little concept of Indian beliefs and life styles and the conquest of such "routine" diseases as diptheria, tuberculosis, rabies, scarlet fever, trachoma, bacillic dysentery, gastroenteritis, pneumonia and chronic ear infections. More Indian doctors and a training program better-related to the realities of reservation life will, he feels, go a long way toward overcoming these obstacles.

Joseph Ball, M.D. (1923-). Born in Bremerton, Washington, Joseph Ball spent most of his childhood on the Klamath Reservation. He attended Santa Clara University in California before becoming the first (and, to date, the only) Indian to graduate from the University of Oregon's School of Medicine. After an internship at Orange County (California) General Hospital, he worked for a year for the Public Health Service at Chemawa Indian School, then spent three years studying psychiatry. A charter member of the AAIP, Dr. Ball practices in Portland, is a clinical instructor in psychiatry at the University and is heavily involved in medical programs affecting the American Indian (Portland Indian Center, Oregon Regional Medical Program, National Mental Health Minority Grant Program, etc.).

Lionel H. deMontigny, M.D., M.S.P.H. (1935-). Dr. deMontigny, a Turtle Mountain Chippewa from North Dakota, John Hay Whitney Fellow, and recipient of an Indian Health Scholarship, graduated from the University of North Dakota and the University of Wisconsin Medical School. After joining the Public Health Service (PHS) he became the first resident appointed to the Division of Indian Health's preventive medicine program at the University of Oklahoma and, upon completion, was named deputy director of the Portland area office of the PHS. Among his special interests are the development of Indian-controlled health programs and the encouragement of young Indians interested in medical careers.

Thomas Burch, M.D., M.P.S. (1918-). Dr. Burch, a winner of the U.S. Public Health Service Medal, is an enrolled member of both the Delaware and Cherokee Tribes. He is a specialist in tropical medicine and in the study of arthritis and rheumatism. A graduate of USC's medical school and John Hopkins University, he has worked in Guatemala and Liberia, conducting research on filariasis (a tropical disease that causes eventual blindness). He also served as a special consultant on that disease to the World Health Organization and has both written extensively and produced a movie about it. Later, in Montana and Arizona, he studied--among the Blackfeet and Pima tribes--the occurrence of arthritic conditions in areas of different (cold vs. hot) climates. Another study among these peoples (and among the Apache, Papago, and Cocopah) revealed a startling (highest in the world) incidence of diabetes and led to the establishment of an

NIH office to help deal with this problem (and with diseases of the gall bladder). Retired from the PHS, Dr. Burch, a member of the AAIP, is now Chief of the Research and Statistics Office of the Department of Health in Hawaii.

Kermit C. Smith, O.D. (1940-). The only known Indian osteopath in America (the federal government estimates, based on population figures, that 64 are needed), Dr. Smith, an Assinibone from Montana and graduate of St. Olaf College and the Chicago College of Osteopathy, practices in suburban Chicago. Also an instructor in Indian lore, he devotes many hours to working with such groups as the Indian Guides and the YMCA.

Sheldon Chicks, M.D. (1934-). A member of the Stockbridge-Munsee Tribe, Dr. Chicks, who hails from Wisconsin, spent a few years working in the factories of Milwaukee and two in the Army before convincing himself of the possibility he might become a physician. At 23 he entered Marquette University, then went on to graduate from their medical school and take an internship in psychiatry at St. Luke's Hospital in Milwaukee and a three-year residency at the Milwaukee County Mental Health Center. After a number of years working for the Center, he entered private practice. A member of the AAIP, he has served as both its secretary and its president and has worked extensively with various Indian groups.

Everett R. Rhoades, M.D. (1931-). Born in Oklahoma, Dr. Rhoades, an enrolled member of the Kiowa Tribe, attended Pennsylvania's Lafayette College before entering the University of Oklahoma's medical school. After receiving his M.D. (he was the first Kiowa to obtain a doctorate), he interned at Gorgas Hospital in Panama, then completed a residency in internal medicine at the Oklahoma Medical Center. Now a professor of medicine at the Center, Dr. Rhoades is a widely-published expert on infectious diseases. A founder of an Indian Health Clinic and past president of the AAIP, he is also heavily involved in other Indian groups and is a member of the Kiowa Tribal Council (helped write the tribal constitution). Believing that their closeness to nature makes Indians particularly well-suited for medical work, he is interested in encouraging new health professionals and in the preservation of Indian culture.

Johanna Clevenger, M.D. (1937-). Of Navajo-White extraction, Dr. Clevenger was born in Albuquerque, New Mexico. Widowed while still in college, she went on, with the support of a Navajo tribal scholarship, to attend Southwestern Medical School in Dallas and there married a fellow student. After an internship in Albuquerque, she, with her husband, spent two years working on the Navajo Reservation before returning to Dallas to complete a residency in psychiatry. A member of the AAIP, she feels strongly about the preservation of traditional Indian culture and is especially concerned with the problems created by separating Indian children from their families to send them away to boarding school (a common government practice).

Leslie Collins, M.D. (1908-). A Leni Lenape from Camden, New Jersey, Dr. Collins, now of Sacramento, California, decided to become a doctor at the age of 24 and started the long road to his goal by enrolling in high school (As a youth he had been told that high school was "unnecessary for someone who would never make it to college."). Accepted as a special premed student at the University of California, he later graduated from their medical school. A specialist in urology, he has a particular interest in alcoholism and in helping Indians

with this problem. Retired from practice, he helped found and now serves on the board of directors of the Sacramento County Detoxification Center and works with the California Intertribal Council's Alcohol Recovery House and an Indian Alcoholics Anonymous group. Currently treasurer of the AAIP, he has taken the cause of better Indian health care to the U.S. Senate. As a volunteer for the California State Department of Education, he works with kindergarten to fourth grade students, encouraging them to consider medical careers, and taking his "Traveling Medicine Show" from school to school, especially in rural communities with large Indian populations.

Linwood Custalow, M.D. A specialist in ear, nose, and throat diseases, allergies, and facial plastic surgery, Dr. Custalow, the current president of the AAIP, practices in Newport News, Virginia. Born in Virginia, he is a Mattaponi who lived on the reservation and attended Indian schools until he graduated from high school. He attended Bluefield College, the University of Richmond, and the Medical College of Virginia, where he also completed his residency. Greatly interested in the health care of his people and in encouraging young men and women to seek higher education, Dr. Custalow travels often to the reservations of Virginia, delivers speeches on Indian concerns and is currently collecting material for a book.

Thomas St. Germain Whitecloud II, M.D. (1914-1972). For Dr. Whitecloud, a Chippewa born in New York City, the road to success was a long and frequently checkered one, a road cluttered with odd jobs (everything from boxing to deep sea diving), attendance at and expulsion from Indian schools, tuberculosis, failing grades at one university, etc. Finally however, he decided on a medical career, with a determination that carried him through the University of Redlands and the Tulane University School of Medicine (graduated in 1943). After serving as a paratrooper and battalion surgeon in World War II, he went to work for the Indian Health Service before entering private practice in a number of small southern communities. In later life he worked with alcoholics and addicts in California, and took a deep interest in Indian problems and in writing and lecturing. One of his sons, Dr. Thomas Whitecloud III (see next entry), is also a physician, a career choice he credits to his father's influence and example.

Thomas St. Germain Whitecloud III, M.D. (1940-). An orthopedic surgeon, Dr. Whitecloud also teaches at Tulane Medical School. Born in New Orleans, he, like his father (previous entry) and grandfather (a lawyer), attended college (Louisiana College, in his case) on a football scholarship. A graduate of Tulane and a founding member and past treasurer of the AAIP, he is involved in a number of activities related to both Indian medical care and the development of tribal crafts.

George C. Moore, M.D. (1935-). Another second generation doctor is obstetrician-gynecologist George C. Moore, the son of C. W. Moore, a now-retired pediatrician. A graduate of Oklahoma State University and Oklahoma University Medical School, Dr. Moore, a Choctaw, interned at Charity Hospital in New Orleans and took his residency at Tulane and Louisiana State University. Now in private practice in Ponca City, Oklahoma, he is involved in such diverse activities as drama, sailing, golf, and speaking to Indian youth groups.

Edward Pointer, M.D. (1927-). Of Cherokee extraction, Dr. Pointer, who was born in Oklahoma, now resides in Tallequah, Oklahoma, where he runs one of the U.S. Indian Health Service's largest X-ray departments. A graduate of Northeastern University and the University of Oklahoma Medical School, he practiced general medicine for a number of years before taking a radiology residency at the University of Arkansas Medical Center. Quite active in both Indian and medical organizations, he is especially interested in improving the medical care available to those living in rural communities.

James Thompson, M.D. (1944-). Born in Oklahoma, Dr. Thompson, a Delaware, graduated from the University of Oklahoma and Tulane Medical School. Interested in the emotional aspects of patient care, he, after two years in the Indian Health Service, decided to become a psychiatrist. Now a resident at Chapel Hill in North Carolina, he plans a career in community psychiatry and is especially concerned with providing mental health care to those who normally could not afford it and in working for the civil rights of mental patients.

H. C. Townsley, M.D. Once a construction worker, Dr. Townsley, a Chickasaw from Kingston, Oklahoma, became the first Indian psychiatrist to work for the Mental Health Branch of the Indian Health Service. A graduate of Tulane and the University of Oklahoma School of Medicine, he worked as a general family practitioner before continuing his studies with the help of a John Hay Whitney fellowship. Following a residency in neuropsychiatry, he directed a methadone program for the state of Oklahoma. Other activities include serving as a mental health consultant for the Norton Sound Health Corporation in Nome, Alaska.

Constance Uri, M.D. Of Choctaw and Cherokee heritage, Dr. Uri is widely known for her activities on behalf of various Indian programs, her work in encouraging Indian girls to go to college, and for her efforts to upgrade the medical facilities and care available to Indians. Born in Arkansas and raised in California, she received her B.A., M.A., and M.D. from the University of Arkansas then returned to California to complete her internship in anesthesiology. In private practice in Los Angeles, she devotes much of her time to doing volunteer work for Indian communities and groups.

Lois Genelle Fister Steele, B.A., M.S. (1939-). An enrolled member of the Ft. Peck Tribes, Mrs. Steele, who was born in Washington D.C., has, after years of teaching science, returned to school and is now (1977) a fourth year medical student at the University of Minnesota. A graduate of Colorado College (B.A., zoology) and the University of Montana (M.S., science teaching), she has taught at the junior high, high school, and college levels and, from 1969 to 1973, was on the faculty of Dawson College where she served variously as dean of women, director of special services and teacher-counselor. Director of the INMED Program at the University of North Dakota from 1973-1974, she has also held several consultantships and written articles on Indian education and health careers and is the recipient of many honors and awards (including the Outstanding Educator of America Award in 1970 and Outstanding Woman Student at the University of Minnesota Medical School in 1976).

Loretta Helle, M.D. (1930-). Now prominent in the field of industrial medicine (and listed in *Who's Who of American Women*), Dr. Helle, the daughter of a mechanic and a school teacher, was born in Nome, Alaska. Half-Eskimo (of the Kawerak Group), she was educated at a public school rather than the more

customary BIA School. Encouraged by her math teacher (the now famous progressive educator, Max Bieberman) to study medicine, she enrolled at Washington State University. A number of small scholarships (including one for being valedictorian of her class) helped but she still found it necessary to work. Further hindered by a bout with tuberculosis, she required two extra years to complete her studies at Washington University Medical School. Moving to San Diego, California with her husband, Dr. Helle went into general practice at San Diego County General Hospital (now University Hospital) then, for a time, worked for the PHS. She also enrolled in and graduated from the University of San Diego Law School and is active in many Indian Organizations.

Fred Kinny, M.D. (1947-). Born in Oklahoma, Dr. Kinny, who is a quarter Osage, received his B.S. (zoology) from Oklahoma State University and his M.D. at Oklahoma University and, in 1976, completed a residency in internal medicine in Tulsa. His future plans include work at an Indian hospital.

Thomas E. Mathewson, M.D. (1936-). Of Cherokee heritage, Dr. Mathewson, who was born in Oklahoma, is related to General Stand Watie (a full-blooded Cherokee), the last Confederate general to surrender. A graduate of the University of Oklahoma and Baylor Medical School, he is now in private practice in Prineville, Oregon.

J. E. McAlister, M.D. (1933-). Another Oklahoman of Cherokee descent, Dr. McAlister practices as a psychiatrist in Norman, Oklahoma. He entered Northeastern State College after several years in the Air Force, and went on to graduate from the University of Oklahoma School of Medicine.

Herbert Fowler, M.D. (? -1977). A Sioux who had been Director of the Whitecloud Center in Portland, Oregon until his sudden death, Dr. Fowler received the U.S.S.R.'s Lenin Award.

MEDICINE, NURSING

Lorene Sanders Farris, R.N., M.S. (1924-). Of Cherokee extraction, Mrs. Farris was born in Vian, Oklahoma, and is a graduate of the Lucy Webb Hayes School of Nursing in Washington, D.C., Washington University in St. Louis, Missouri, and Barry College in Miami Shores, Florida. She has earned additional credits in educational psychiatry at Louisiana State University, guidance and reading programs and problems at Barry, and junior college teaching methods at the University of Miami. A clinical specialist in the maternity department of Jackson Memorial Hospital in Miami, she developed the materials for and now conducts a parent education (antepartum and postpartum) class. A member of the American Nurses Association and very active in their human rights and affirmitive action programs, she was their U.S. Nominee for the 3M International Nurses's Association Award and, as winner of the U.S. Award, spent a summer studying Scandinavian child care facilities. One of the founders and presently a Board Member of the American Indian Nurses's Association (Appendix C), she has published articles on Indian maternity care; the Indian child's struggle to survive; and contributed two chapters to McClain and Graggs' *Scientific Principles of Nursing* (C.W. Mosby, C., 3rd Edition, 1969). Her husband, Charles, who is also Indian, is an associate professor in the School of Social Work at Barry College.

Janice Kekahbah, R.N., M.A. (1940-). Executive director of the American Indian Nurses' Association, Ms. Kekahbah, a Kaw and Potawatomi from Mayetta, Kansas, is a graduate of St. John's School of Nursing, the University of Oklahoma, and New York University (M.S. in community mental health nursing-child psychiatry). She has held a number of nursing positions (staff, supervisory, and faculty); conducted research in Indian health care and mental health programs; directed a mental health/alcohol treatment program; and served as a consultant to various Indian health groups and to the Academy of Child Psychiatry. A lecturer on Indian health, the role of Indian women and alcohol treatment programs, she is very active in both professional and cultural organizations.

Maxine Chuculate, R.N. (1929-). Mrs. Chuculate, who was born in Seiling, Oklahoma, first became interested in nursing in 1962 when she enrolled as an eighth grade student at the Haskell Institute in Lawrence, Kansas. Admiring the work of an Indian nurse at the school, she participated in the school's nursing program in her senior high years. She then went on to become one of only three students in 1973 to receive a degree in nursing from the University of Kansas. President-elect of both the American Indian Nurses' Association and District 19 of the Oklahoma State Nurses' Association, she is district supervising nurse for the Oklahoma State Department of Health. Listed among her interests is working with the Sequoyah Foster Grandparent Project; a program which helps both the elderly and the very young by providing foster grandparents to institutionalized children.

Audra Pambrun, R.N. (1929-). The second Blackfeet to become a nurse, Ms. Pambrun, who was born in Montana, is Director of Community Health Aides for the Blackfeet Community Action Program, a job which takes her to homes all over the tribe's 1,500,000 acre reservation. The recipient of many honors, she is especially interested in working to lower the suicide rate among young Indians.

Major Loretta S. Jendritza, R.N. The first Navajo woman to become a major in the Air Force, Major Jendritza, who was born in New Mexico, earned her R.N. at Sage Memorial Hospital. An operating room supervisor at George AFB, she served in Vietnam and is a popular speaker on the subject of Indian women in the military.

Frela Owl Beck, R.N., B.S. (1939-). A Cherokee from Wisconsin, Ms. Beck graduated with high honors from Michigan State University.

Joanne Green Labin, R.N., B.S. (1942-). An instructor of nursing, Ms. Labin, a Mohawk/Seneca from New York, graduated from D'Youville College and attended the University of Buffalo.

MEDICINE, PHARMACY

Francis Quam, B.S. (1939-). The first Zuni pharmacist, Mr. Quam, who is from New Mexico and graduated from the University of Cincinnati, is now deputy chief of the Alaska Native Hospital in Anchorage.

MISCELLANEOUS

Paddy Martinez. A Navajo sheepherder who discovered an unusual yellow rock on Haystack Mountain, Mr. Martinez opened the door to New Mexico's uranium industry.

Yeffe Kimball. Known as a pioneer in the field of space art, Ms. Kimball, an Osage from Oklahoma, has for many years created prophetic paintings of lunar concepts and outer space progress using acrylics and sculpture painting techniques. NASA commissioned her to do a painting, Lunar Terminator, which toured the country under the auspices of the Smithsonian.

Clara Sue Kidwell, Ph.D. (1941-). Dr. Kidwell, an associate professor in the Native American Studies Program at UC Berkeley, was born in Tahlequah, Oklahoma. She received her B.A. (in letters), M.A., and Ph.D. (in history of science) at the University of Oklahoma in Norman (Ph.D. dissertation--"The Accidemia Dei Lincei and the Apiarium: A Case Study of the Activities of a Seventeenth Century Scientific Society"). On the editorial board of *The Indian Historian* and a member of several committees and organizations (National Community Education Advisory Council, American Civil Liberties Indian Rights Committee, Society for the Advancement of Chicanos, and Native Americans in Science (Appendix A), History of Science Society, and National Indian Education Association), she has written extensively on ethnoscience and such other subjects as present day Indian education and the role of women in Indian societies.

John C. Rainer, Sr. Although not himself a scientist, Mr. Rainer, a full-blooded Taos Pueblo Indian, has (through his organization, American Indian Scholarships, Inc., (Appendix B) helped make possible the careers of many Indian scientists. His belief that better education is vital to his people led him to become a champion of the Indian graduate student and to seek, via his organization, financial help for them from private and government sources. Starting in 1970 with 15 students, the program has since provided grants to over 1000 candidates for masters' and doctoral degrees. Another indicator of his strong belief in education can be seen in the work of his children--Ann, a medical student at the University of Colorado; John, Jr., assistant coordinator of Indian Personnel Services and the Indian Student Choir at Brigham Young University (working toward a Ph.D. in educational psychology); and Howard, director of the Institute of American Indian Studies in the Department of Continuing Education at Brigham Young.

A graduate of Bacone Jr. College in Muskogee, Oklahoma, the University of Redlands, and U.S.C., Mr. Rainer has served on many state and national commissions, including a cabinet level appointment to the National Council on Indian Opportunity. As chief spokesman for the Council, he was instrumental in the fight to return government-held lands to the Indians.

Rayna Diane Green, Ph.D. Director of the American Association for the Advancement of Science (AAAS) project on Native Americans in Science (Appendix A), Dr. Green works to develop programs and projects for American Indians in science, social science, health, natural resources, and engineering; obtain funding; and coordinate the efforts of government, private, Indian, and educational institutions. A graduate of Southern Methodist University and Indiana University (Ph.D. in folklore and American studies--dissertation, "The Only Good Indian: The Image of the Indian in American Vernacular Culture"), she lists various aspects

of American folklore and culture and multi-cultural education among her specialities. A prolific writer, she has compiled several reports on Indian scientists and science opportunities (see bibliography); published many articles; and presented many papers on Indian affairs, folklore, and racial and women's roles in American society.

Kiutus Tecumseh, B.A. (1949-). Mr. Tecumseh, the son of Chief Ciutus and Marie Tecumseh, and a graduate of Washington State University (Pullman), is a Winnebago/Sac-Fox Indian. An administrative officer at the Los Alamos area office of the U.S. Energy Research and Development Administration (ERDA), he works primarily in the areas of industrial, labor, and personnel relations. A member of the advisory council for the Native American Program, College of Engineering, University of New Mexico (NAPCOE), the National Indian Education Association (NIEA), the Speaker's Bureau for the American Association for Affirmative Action (AAAA), and the Los Alamos Pentathlon Committee, he has also developed a number of training courses (emphasis on employment opportunities for Indians and women) for ERDA and the Atomic Energy Commission. Especially interested in Native American problems and programs, he has served as a delegate to the White House Conference on Youth (Race and Minority Relations segment) and lectured at the University of Idaho.

OTHER INDIAN PROFESSIONALS

Too little information was available on the following people to make individual entries possible:

1. Dr. James F. Hamburg, Assistant professor, geography and geology, Moorhead State University, Minnesota
2. Ms. Georgia Pedro (Laguna), field sanitarian, Santa Fe, New Mexico
3. Mr. Irvin Jose, M.S. (Laguna), physicist, LASL
4. Mr. Gilbert Suazo (Taos), physicist, LASL
5. Dr. Clifford R. Schumacher (Chippewa), Laboratory of Nuclear Studies, Cornell University
6. Ms. Carol Metcalf (Penobscot), geologist, University of New Mexico
7. Mr. Morton Dreamer, Civil engineer, BIA
8. Mr. Ed Gonzales, Civil engineer, BIA
9. Mr. Phil Stevens, President, Ultra Systems Inc.
10. Mr. Jim Shorty, Department of Engineering, University of New Mexico

APPENDIX A

PROGRAMS FOR AMERICAN INDIAN STUDENTS

1. Native American Activities Program of the Engineering School of Clarkson College of Technology, Potsdam, New York. Development of this program began in 1973. Originally funded entirely by the college, it soon received additional financing from the ALCOA Foundation, Carrier Corporation, Celanese Corporation, Eastman Kodak, Engineer's Council for Professional Development, General Electric Foundation, International Paper Company, Turner Construction Company, and Union Carbide Corporation. By 1976, the following activities were underway:

   a. A Summer College Orientation Program in Engineering and Science (SCOPES) for 10th, 11th and 12th grade students. Designed to offer career information to the participants, SCOPES involves a two-week schedule of lectures, demonstrations, class visits, and discussions among students, faculty members, and representatives from various industries. (SCOPES has twice been chosen as one of the 22 minority high school programs to participate in the Minority Introduction in Engineering Program sponsored by the Engineer's Council for Professional Development). In 1976, 25 American Indian (and four Black and two Puerto Rican) students participated in the program (21 had definite plans to attend college with 12 definitely interested in engineering or science). Of special interest to these students was the chance to meet and talk with an Indian mechanical engineer (male) and an Indian computer analyst (female).

   b. Pre-College Summer Institute (PCSI). A four-week summer program for high school juniors and seniors. PCSI offers participants interested in engineering and science the opportunity to take (and, upon successful completion, receive credit for) a freshman level college course. In 1976, 16 minority students enrolled, 12 of them American Indians.

   c. Junior High School and Grammar School Activities. Designed to present career choice information to younger Indian children, this program includes a slide show and discussion program which is taken to reservation education centers and New York schools with heavy Indian enrollments, and the distribution of career guidance packets to people working with Indian students at the grammar school level.

   d. Guidance Counselors and Indian Reservation Leaders. At this special one-day conference for persons (mostly Indians) who counsel Indian students (grade school to college level), the participants receive engineering career and education guidance material; tour the Engineering School; and discuss opportunities in engineering. Stress is placed upon academic requirements and the variety of career opportunities available.

e. Adult Education. In 1976, two members of Clarkson's faculty offered a college credit course, "Introduction to Environmental Science" at the Akwesasne Education Center, St. Regis Indian Reservation, Hogansburg, New York. The 25 Indians who participated received credit toward a two year A.S. degree at nearby Mater Dei College. Class activities included visits to two sewage treatment plants and to the Environmental Engineering Lab at Clarkson. The 1977 course in introductory biology was also designed to be ecologically- and nature-oriented, a tribute to the American Indian's special interest in and concern for environmental matters.

Dr. Edward T. Misiaszek (Clarkson's Associate Dean of Engineering), who is in charge of this special minority program, is the only non-Indian appointee to the American Indian Advisory Group in Engineering of the National Research Council. A graduate of Clarkson and the University of Illinois, his major fields of interest are civil engineering, soil mechanics, engineering, geology, and structures.

2. Lummi Indian School of Aquaculture. On Lummi Island, one of the San Juan Islands off the coast of Washington and part of the Lummi Indian Reservation, is found the Lummi Indian School of Aquaculture. Because fish and oysters can be grown much faster in a controlled environment than in the wild, the people of this area have developed a sea pond, and fish and shellfish hatcheries. In order to train their own aquaculture techniciens, the school described their approach in the following report *A Culturally Relevant Curriculum* (Condensed from *Change Magazine, Report on Teaching,* July, 1976):

> The Lummi Indian School of Aquaculture (LISA) is a practically oriented institution offering education and training in aquaculture and aquatic sciences to Indians of all tribal affiliations.
>
> While seeking community college status itself, LISA is presently accredited through Whatcom Community College for the granting of a one-year certificate as well as a two-year Associate of Arts degree. Credits earned are transferable to other colleges in the state. Enrollment is open to all students over 18 who are of at least 25% Indian ethnicity.
>
> The purpose of the school is to increase the employment potential of its students through training in such skills as aquaculture and fisheries management and to encourage the economic development of aquatic resources found on Indian reservations.
>
> The main campus on Lummi Island houses classrooms, laboratories, a seawater system and library, and it is there that students receive their primary education in basic biology, ichthyology, limnology, parasitology, aquacultural science and management, and related subjects.
>
> Approximately half of the students' time, however, is spent on field trips and on-the-job training, utilizing LISA's own research

vessel and specialized laboratories as well as aquacultural facilities in commercial operation on the Lummi Reservation. Curricular interest is enhanced by the opportunity to undertake individual research projects.

LISA also requires that all students take a program of liberal arts courses at Whatcom College.

80% of the entering students do complete their training satisfactorily. And 70% of LISA's graduates have been placed in relevant employment, many returning to their reservations to initiate or operate commercial aquacultural projects.

For more information: Paul Winkler, Director, Lummi Indian School of Aquaculture, P. O. Box 11, Lummi Island, Washington, 98262, (206) 758-2368.

3. Minority Biomedical Support Program. Graduate career opportunities in biomedical research at the University of California, Santa Cruz. Designed to help increase the numbers of minority scientists in health fields, the MBS Program offers financial support (yearly stipend of $3900, travel expenses to one national scientific conference, and one-third of yearly registration fees) to successful applicants. Information about this program may be obtained from Dr. Victor Rocha, Biology Board of Studies, University of California, Santa Cruz, California 95064.

4. Native American Program
College of Engineering
University of New Mexico
Albuquerque, New Mexico 87131

5. M.P.H. Program for Native Americans
School of Public Health
University of California
Berkeley, California 94704

6. Native American Programs
College of Engineering
University of New Mexico
Albuquerque, New Mexico 87131

7. Native American Programs
College of Engineering
Oklahoma University
202 West Boyd
Norman, Oklahoma 73069

8. Native American Career Education
School of Natural Resources
Humboldt State University
Arcata, California 95521

9. Navajo Community College
Shiprock, New Mexico 87420

10. Haskell Indian Junior College
Lawrence, Kansas 66044

11. Navajo Community College
Tsaile, Navajo Nation, Arizona 86556

12. Navajo Tribal Youth Program. Sent 1600 Navajo students to visit scientific and engineering companies in Southern California in 1977.

13. Rockwell Center National Space Division in Downey has both an advanced Career Training Program for all minorities (four $10,000 scholarships and "hands-on" training) and a special summer employment program.

These are but a few of the many programs available to Indian students. The AAAS/OOS Project on Native Americans in Science: Inventory of Projects and Programs in Science for Native Americans (Prepared for AAAS by Shirley Malcom, Rayna Green and Jean Kaplan), contains a detailed listing of more than 100 programs (elementary, secondary, college, graduate, professional, post-secondary, non-collegiate) of interest to Indian students.

APPENDIX B

AGENCIES TO CONTACT FOR INFORMATION AND POSSIBLE FINANCIAL HELP FOR INDIAN STUDENTS

(Selections taken from the *Health Career Handbook* of the AAIP):

1. American Indian Scholarship, Inc.
   211 Sierra, S.E.
   Albuquerque, New Mexico 87108

2. The Scholarship Office
   (Student's Tribe)
   Care of Tribal Headquarters

3. Indian Health Service
   Care of Manpower Development Office
   DHEW
   Rockville, Maryland

4. INMED
   University of North Dakota
   Grand Forks, North Dakota

5. Med-Start
   University of Arizona
   Tucson, Arizona

6. BIA
   Care of Agency Superintendent
   (Student's Agency)

7. Association of American Indian Physicians
   1300 McGee Drive
   Norman, Oklahoma 73069

8. Office of Student Affairs
   Navajo Health Authority
   P.O. Box 643
   Window Rock, Arizona 86515

9. United Scholarship Services, Inc.
   941 E. 17th Ave.
   Denver, Colorado

10. American Indian Fellowship Grants
    Office of Indian Education
    Department of Health, Education and Welfare
    Washington, D.C.

Other sources--of financing or for advice--available to all students, may be found on a list in the *Health Career Handbook* published by AAIP, (entry 7 above).

APPENDIX C

PROFESSIONAL ASSOCIATIONS/ADVISORY COUNCILS

1. Association of American Indian Physicians
   1300 McGee Drive
   Norman, Oklahoma 73069

   (Professional association of American Indian and Alaskan Native physicians--of at least one-eighth Indian heritage--active in recruiting Indian students into health careers; providing advice on Indian health matters to the government and other groups; and serving as a forum for the exchange of information.)

2. American Indian Nurses Association
   231 S. Peters
   Norman, Oklahoma 73105

   (Professional organization of American Indian R.N.'s with an interest in promoting Indian health, recruiting Indian nurses, developing nursing programs, and alerting Indians and non-Indians to the health problems of Indians. One of their projects is the development of a three-stage nursing program (with Haskell and other schools) to help practical nurses advance professionally by earning, first an A.D. in nursing, then a B.S.)

3. Network of Indian Psychologists
   Department of Psychology
   University of Washington
   Seattle, Washington 98185

   (Includes professionals, paraprofessionals, and students in the U.S. and Canada. Two-thirds are Indian; the others have considerable experience and interest in working with Indians.)

4. Society for the Advancement of Native American and Chicano Scientists
   University of New Mexico School of Medicine
   P. O. Box 3831
   Albuquerque, New Mexico 87110

5. National Society of American Indian Engineers
   School of Engineering-Nuclear Engineering
   University of Oklahoma
   Norman, Oklahoma

6. Council of Native American Architects and Engineers
   2431 SW 325th Street
   Federal Way, Washington 98003

7. National Academy of Sciences
   Council on Engineering
   Minority Committee, Native American Advisory Panel
   School of Engineering, Special Programs
   University of New Mexico
   Albuquerque, New Mexico 87131

8. American Indians in Engineering Committee
College of Engineering
Arizona State University
Tempe, Arizona 85281

9. American Indian Higher Education Council
1626 High Street
Denver, Colorado 80218

10. Intra-Departmental Council on Indian Affairs
U.S. Department of Health, Education and Welfare
Suite 819, Riviere Building
330 Independence Avenue, S.W.
Washington, D.C. 20201

11. American Indian Council of Architects and Engineers
P. O. Box 111
Edmund, Oklahoma 73034

12. American Indian Policy Review Commission
Congress of the United States
House Office Building, Annex #2
2nd and D Streets, SW
Washington, D.C. 20515

13. Project on Native Americans in Science
Office of Opportunities in Science
American Association for the Advancement of Science
1776 Massachusetts Avenue, NW
Washington, D.C. 20036

14. Committee on Minorities in Engineering
National Research Council
2101 Constitution Avenue, NW
Washington, D.C. 20418

15. North American Indian Women's Association
SR 3 Box 30586
Fairbanks, Alaska 99701

16. White Cloud Center
Gaines Hall
3181 S.W. Sam Jackson Park Road
Portland, Oregon 97201

(National Center for American Indian and Alaskan Native Mental Health Research and Development--affiliated with, and located on the campus of the University of Oregon Health Sciences Center.)

APPENDIX D

OTHER COMPANIES, GROUPS, ETC. OF SPECIAL INTEREST TO INDIAN STUDENTS

1. Navajo Agricultural Products Industry, 703 West Broadway, Farmington, New Mexico, created to plan, develop, and operate all tribal agricultural projects, including the Navajo Indian Irrigation Project--110,630 acres of sprinkler-irrigated farmland in New Mexico. Also involved in construction of needed facilities, lamb feeding and livestock management.

2. Fairchild Camera and Instrument Company, Shiprock, New Mexico.

3. AINA/Allstate Scholarships, 231 S. Peters, Norman, Oklahoma, 73069. For nurses.

4. Navajo Community College programs, Shiprock Branch, Shiprock, New Mexico.

5. Bibliography of works related to Native American Science Education and Manpower Development by Rayna Green and Jean Kaplan: AAAS, 1776 Massachusetts Avenue, NW, Washington, D.C., 20036.

6. Yakima Nation (Industrial Park--hardwoods, furniture, and fiberglass boat companies). Further information available from Overall Economic Development Committee, P. O. Box 632, Toppenish, Washington.

7. Engineering Career Opportunities, Rockwell International, Space Division, 12214 Lakewood Blvd, Downey, California, 90241.

8. Apache Marketing Cooperative Association, San Carlos, Arizona--harvests and processes jojoba nuts and sells the oil to perfumers and cosmetic manufacturers, especially in Japan. (Cabazon Indian Reservation near Indio will be the focal point of a research program to experiment with commercially planting this bush.)

9. Development Associates, Inc., Washington, D.C. (Indian-owned corporation).

APPENDIX E

The following people provided material used in the preparation of this chapter:

1. Mrs. Glenda Ahhaitty
2. Dr. Don Ahshapanek
3. Mrs. Arnold T. Anderson
4. Mr. T. S. Ary
5. Dr. Carolyn Attneave
6. Dr. Raymond J. Barreras
7. Dr. Bahe Billy
8. Dr. Ronald R. Bourassa
9. Dr. Thomas Burch
10. Mrs. Ruth M. Christensen
11. Mrs. Maxine Chuculate
12. Mr. Don Clark
13. Dr. Leslie Collins
14. Mr. Alfred Q. Colton
15. Mr. Roy Cook
16. Dr. Terry Denny
17. Dr. Frank C. Dukepoo
18. Mr. Jerry Elliot
19. Dr. Wayne H. Evans
20. Mrs. Lorene Sanders Farris
21. Dr. Rayna Green
22. Mr. Curtis Grinnel
23. Mr. Leo David Jacobs
24. Mr. Addison Jump
25. Ms. Janice Kekahbah
26. Dr. Clara Sue Kidwell
27. Mr. Martin Link
28. Mr. Neal A. McCaleb
29. Dr. Taylor McKenzie
30. Dr. Edward T. Misiaszek
31. Dr. Kirmach Natani
32. Dr. Clifton Poodry
33. Mr. John C. Rainer
34. Dr. Jack R. Ridley
35. Dr. Miguel Rios
36. Mr. John C. Rouillard
37. Dr. Loye M. Johnson Ryan
38. Dr. Robert Anthony Ryan
39. Dr. Albert J. Snow
40. Dr. George Blue Spruce, Jr.
41. Ms. Lois Genelle Fister Steele
42. Agnes N. Stroud (nee Schmink)
43. Mr. Kiutus Tecumseh
44. Mr. George Thomas
45. Mr. James M. Tutt
46. Dr. Charles B. Wilson
47. Mr. William Wilson
48. George Yates
49. Mr. Walton Youngblood

BIBLIOGRAPHY

Almstedt, Ruth Farrell. "Diegueño Curing Practices." San Diego Museum of Man Papers No. 10. January 1977.

_____. *American Indian Doctors Today*. Grand Forks, North Dakota: University of North Dakota Press 1976.

American Indian Nurses Association. Informational brochures.

American Indian Scholarships, Inc. Informational brochures.

_____. "1976 Annual Report, Native American Activities Program of the Engineering School of Clarkson College of Technology." Potsdam, New York.

_____. "An Open Learning and Career Mobility Nursing Program for American Indians - A Feasibility Study." American Indian Nurses Association.

_____. "Arizona Indians to Sell Jojoba Oil to Japan Firm." *San Diego Union*, May 20, 1977.

Association of American Indian Physicians. Informational brochures.

Aveni, A. F.; Gibbs, S. L. and Hartung, H. "The Caracol Tower at Chichen Itza: An Ancient Astronomical Observatory?." *Science*. Vol. 188, No. 4192. June 6, 1975.

Bada, J. L., Schroeder, R. A., and Carter, G. F. "New Evidence for the Antiquity of Man in North America Deduced from Aspartic Acid Racemization." *Science*. Vol. 184, No. 4138, May 1974.

Balderidge, Gary. "Indian M.D.s - A Dream on Its Way." *Albuquerque Tribune*. February 23, 1976.

Bossert, L. Joy. "Small Technology Development Proposed as Navajo Alternative." *Navajo Times*. March 3, 1977.

Briggs, Georgia; Tutt, James; Briggs, Lee, and Reno, Phillip. "Energy, Technology and the Navajo Incorporative Model." Abstract.

Briggs, Lee, and Tutt, James. Abstract describing proposed programs for the Navajo Community College.

Brown, Dee. *Bury My Heart at Wounded Knee*. New York: Bantam Books, 1971.

Brown, Janet W. "Native American Contributions to Science, Engineering and Medicine." *Science*. Vol. 189.

Brown, Janet W., and Green, Rayna. "Native Americans in Science." *The Exchange: A Journal of Native American Philanthropic News*. May 1976.

Curtin, L.S.M. "Some Plants Used by the Yuki Indians of Round Valley, Northern California." Southwest Museum Leaflet, 1957.

Dennis, Henry C., Ed. *The American Indian 1492-1970*, Dobbs Ferry, New York: Oceana Publications, Inc., 1971.

Eddy, John A. "Astronomical Alignment of the Big Horn Medicine Wheel." *Science*. Vol. 184, No. 4141. June 7, 1974.

Elliott, Jerry. "Careers for Tomorrow." Address given at NASA Space Symposium, University of Oklahoma, March 1977.

Elliott, Jerry. "Mother Earth.....Father Sky." Address given at NASA/Oregon State University Program, June 1976.

Elliott, Jerry. "The American Indian: From Arrows to Engineering.....Tomahawks to Technology." Address given at FATE (First Americans, Tomorrow's Engineers) Program, June 1976.

Elliott, Jerry. Untitled address given during the celebration of the National Native American Awareness Week, October 14, 1976.

_____. "Engineering Career Opportunities." Rockwell International pamphlet.

Fadden, Ray, and Ridley, J. R., Ed. "On Indian Contributions to the United States." Paper presented to the Memramcook Conference of North American Indian Young People. Talmaks, New York.

Grant, Michael. "Miss Indian America - A bicultural, Traditional Apache." *San Diego Union*. July 2, 1977.

Green, Rayna, and Malcom, Shirley. "AAAS Project on Native Americans in Science." *Science*. Vol. 184, November 5, 1976.

Green, Rayna, and Malcom Shirley. "Native American Project Finds Some Barriers Breaking Down." *Science*. Vol. 195, January 7, 1977.

Green, Rayna. "Recommendations for the Improvement of Science and Math Education for American Indians." *BIA Education Research Bulletin*. Vol. 5, No. 1 . January 1977.

Green, Rayna D. "The Barriers Obstructing the Entry of Native Americans Into the Natural Sciences." AAAS, October 1976.

Gridley, Marion E. *Indians of Today*. ICFP, Inc., 1971.

_____. "Indian Organization Honors JSC Engineer Jerry Elliott." *Roundup*. (NASA Johnson Space Center paper), Vol. 15, #22, November 5, 1976.

_____. *Indians of North America* (Filmstrip). National Geographic Society, 1973.

_____. "Industry Invades the Reservation." *Business Week*. April 4, 1970.

Jenkins, Evan. "Literacy Through Sociolinguistics." *Change Magazine: Report on Teaching*, #6, Vol. 8, July 1976.

Jennings, Don., Ed. *American Indian Health Careers Handbook*. Norman, Oklahoma. Association of American Indian Physicians.

Jerome, Jim. "A Medicine Man With an M.D. Who is Serving the Navajos." Source unknown.

Katz, S. H., Hediger, M. L., Valleray, L. A. "Traditional Maize Processing Techniques in the New World." *Science*, Vol. 184, No. 4138, May 17, 1974.

Kidwell, Clara Sue. "Science and Ethnoscience." *The Indian Historian*, Fall, 1973.

Kolstad, C. D., Grimser, D. P., Reno, P., and Tutt, J. M. "Appropriate Technology and Navajo Economic Development." 1976.

LaFarge, Oliver. *A Pictorial History of the American Indian*. New York: Crown Publishers, Inc., 1956.

_____. Lummi Indian School of Aquaculture 1975 Catalog.

Malcom, Shirley, Green, Rayna, and Kapler, Jean. "AAAS/OOS Project on Native Americans in Science - Inventory of Projects and Programs in Science for Native Americans."

Martinez, J. V. *Directory of Spanish Surnamed and Native Americans in Science and Engineering*. New York: Privately printed by Eastman Kodak Co., 1972.

_____. *Minority Profiles*. NASA.

_____. Newsletter of the American Indian Nurses Association." Vol. 3, No. 1. August--September 1976.

_____. "New York Indian Wins Business Honors," *The San Diego Union*. July 11, 1977.

Petty, Roy. "Medical Practice, Navajo Style: White Man's Rules Go Out the Window." *Empire Magazine, The Denver Post*. December 8, 1974.

Porter, C. Fayne. *Our Indian Heritage - Profiles of 12 Great Leaders*. Philadelphia: Chilton Book Co., 1964.

_____. "Progress Report 1975-76, Navajo Agricultural Products Industry." Farmington, New Mexico.

Sando, Joe. *Pueblo Indian Biographies*. Albuquerque: University of New Mexico.

Sarton, George. *A History of Science*. New York: W. W. Norton and Co. 1952.

Snow, Albert J. "American Indian Ethnoscience." *The Science Teacher.* Vol. 39, No. 7. October 1972.

Snow, Albert J. "The American Indian Knew A Better Way." *The American Biology Teacher.* Vol. 35, No. 1. January 1973.

Snow, Albert J. "Ethno-science and the Gifted." *Journal of American Indian Education,* Vol. 16, No. 12. January 1977.

Terrell, John Upton. *American Indian Almanac.* New York/Cleveland: The World Publishing Co., 1971.

Walker, Edwin F. "America's Indian Background." Southwest Museum Leaflets. No. 18.

Walker, Edwin F. "World Crops Derived From the Indians." Southwest Museum Leaflets. No. 17, 1967.

Winkler, Paul. "A Culturally Relevant Curriculum." *Change Magazine: Report on Teaching.* Vol. 8, No. 6. July 1976.

_____. "Yakima Indian Nation." Brochure prepared by the Yakima Indian Nation Media Service.

SUGGESTED WAYS TO USE MATERIALS

Prepared by

Mary Domb Mikkelson

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SUGGESTED WAYS TO USE THESE MATERIALS

1. Part of regular curriculum discussions

   a. Heart transplants, artificial hearts, mechanical stimulation of the heart, blood, and blood plasma; mention the work of Dr. Domingo Liotta (Hispanic), Drs. Paul I. Terasaki and Tetsuo Akutsa (Japanese), Mr. Otis Boykin (Black), and Dr. Charles Drew (Black).

   b. In the development of the atom bomb (the Manhattan Project), describe the contributions of Dr. Chien-Shiung Wu* (Chinese, female), Dr. Ernest Wilkins, Jr. (Black), and Mr. Arnold Anderson (American Indian)

   c. For environmental concerns, study the beliefs and practices of the American Indians.

2. Topics for oral and written reports (See list of suggested topics in this section.)

   a. Classroom discussions:

      -teacher- or student-led

      -panel

      -small-group (Discuss different subjects and report on them, or discuss the same subject and compare findings.)

      -question-and-answer session (See list of suggested approaches in this section.)

   b. Written reports, assigned or student's choice of topic, based on classroom material and/or outside research:

      -biographical study (Note: Discuss elements necessary in a biography.)

      -contributions to a particular field

      -a look at the sociological factors that affected a given scientist or group

3. Short units on special topics

   a. The cultural and environmental bases for Hispanic, Black, Asian and American Indian approaches to science, engineering and medicine

   b. Educational, employment, and financial opportunities available to minority and female** students interested in careers in these fields

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*The slide/cassette set "Women in Science" available through Instructional Media Center, includes an interview with Dr. Wu.

**The City Schools' Instructional Bulletin, *Women in the Science Professions*, by Penny A. Wilson, could be effectively used in conjenction with this guide book.

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SUGGESTED WAYS TO SUPPLEMENT THESE MATERIALS

1. Prepare bulletin board displays.

   a. Posters:

      -Use the posters included in each section for bulletin board display.

      -Have students design posters from photographs they find of the scientists.

   b. Newspaper and magazine reports:

      -General- and special-interest publications (A few articles about Indian scientists are on file at the science specialist's office.)

      -Tribal and other ethnic publications, including ones in languages other than English (Minority students may be able to provide these.)

2. Arrange lectures by minority scientists (and/or affirmative action officers) from local businesses and schools.

   a. The "Meet the Scientist" program -- lists and request forms are sent to schools in early September. Requests for first semester must be in by September; those for the second semester, by early December. The list usually includes, among others, the following names:

      -Arnold Flores (Hispanic) of N.O.S.C.--"From Wetback Farmhand to Electronic Scientist"

      -Herb Delgado (Hispanic) of N.O.S.C.--"Preconceived Negatives Are Really Positives" (Will present program in Spanish if desired.)

      -John T. Shen (Chinese) of N.O.S.C.--"Everything You Want to Know About Computers But Were Afraid to Ask," "Memory Technology," "Large-Scale Integration (LSI)--What Are They and What They Can Do for You"

      -Dolly DeMarco (female) of N.O.S.C.--"What Is Available to Women in Government Service and How to Achieve Your Goals"

      -Louise Fransdal (female) of N.O.S.C.--"Who Cares About Sonar? We Do"

      -C. A. Hui (Chinese) of N.O.S.C.--"Growth Determinants in Marine Mammals"

      -Evelyn Lowe (female) of N.O.S.C.--"Women and Affirmative Action," "Non-Traditional Jobs," "Careers in Federal Service"

      -Dr. Vernon L. Avila (Hispanic) of S.D.S.U.--"Hormones and Behavior," "Career Opportunities for Minorities in Science"

-Jan Larsen (female) of N.O.S.C.--"San Clemente Island Natural Resources Program," "Island Ecology and Biogeography"

-Dr. Jan Victoria (female) of the Natural History Museum--"Birds--Those Magnificent Flying Machines"

b. Other speakers' bureaus, i.e. University of California, San Diego; Grossmont Hospital Auxiliary Office; Naval Ocean Systems Center; Salk Institute for Biological Studies; San Diego County Medical Society, Natural History Museum, San Diego State University, University of San Diego, etc.

c. Volunteers: Personal arrangements for other speakers can be made with friends and relatives of teachers and students. Consideration should be given to their work/business schedules.

3. Schedule field trips.

a. Labs of minority scientists

b. Museum of Man and other displays of the history and culture of different ethnic groups

c. Historical sites such as the Pala Indian Mission (Points of interest at Pala include the remains of the old aqueduct, details of construction, the cemetery, jail, chapel, etc. Many educational and community programs for the area's Indians are offered at the mission. Father Bart is the priest in charge of the mission.)

d. Special programs offered throughout the community on such occasions as Martin Luther King, Jr. Day; Cinco de Mayo; Native American Awareness Week; etc.

4. Provide reference materials about and/or by minority students and their cultures.

a. Contact school's career guidance counselor:

-lists of educational programs
-scholarships and financial aid
-minority professional groups
-bibliographies
-publications picturing successful minority scientists
-career opportunities and information
-skills and training needed for scientific careers

b. Ethnic groups and organizations

c. Professional Library, San Diego City Schools

d. San Diego city and county libraries

AUDIOVISUAL MATERIALS

The materials listed here are available from the San Diego City School's Instructional Media Center. An additional list of materials may also be found in *Women in the Science Professions*. Not all materials listed here refer to scientific achievements; some are of a general nature.

BLACK CONTRIBUTORS AND BLACK HISTORY

Films

MPF 105000	Booker T. Washington (18 min)
MPF 105001	Booker T. Washington, Copy B (Col, 11 min)
MPF 224600	Dr. George Washington Carver (11 min)
MPF 422750	Hurdler (Col, 16 min) (Dr. Charles Drew)
MPF 010200	Africa: Historical Heritage (Col, 9 min)
MPF 030300	Ancient Africans (Col, 27 min)
MPF 102300	Black History--Lost, Stolen or Strayed, Part I (Col, 28 min) (includes Black contributions to the development of the Unites States, African history, and comments on the lack of textbook information on Blacks, by Bill Cosby)
MPF 605000	Negro Americans (Col, 15 min) (includes roles in United States history, accomplishments)
MPF 605200	Negro Heroes from American History (Col, 11 min)

Filmstrips

Fs 301.45	George Washington Carver (72 Fr)
Fs 301.45	American Negro Pathfinders (6 Fs, Manual)

Soundstrips

Ss 301.45	Benjamin Banneker and Robert Smalls (Col, 1 Rec, 2 Fs, 2 manuals)
Ss 301.45	George Washington Carver: A Study in Genius (Rec, Fs)
Ss 301.45	Negro in American History (Col, 2 Fs, 1 Rec, 2 Manuals)
Ss 916.1	Seeing Northern Africa (Col. 6 Fs, 6 Cass, Manual)
Ss 916.611	Nomads of the Sahara (Col, 2 Fs, 2 Cass, Manual)
Ss 916.8	Seeing Southern Africa (Col, 4 Fs, 4 Cass, Manual)

Cassettes

Cass 925	Blacks in Science (2, Manual)
Cass 301.451	Booker T. Washington (10 minutes)

Records

Rec 301.45	George Washington Carver (2)
Rec 301.45	Great Negro Americans, Vol. 1
Rec 973	George Washington Carver

Study Prints

SP-S 301.451 Business and Professions (24)
SP-S 301.451 Negroes of Achievement (1865-1915) (24)
SP-S 301.451 Contemporary Black Biographies (16, Manual)
SP-S 301.451 Negroes in Our History (24)
SP-S 301.451 Science and Invention (24)
SP-S 301.451 Famous Black Americans (12, Color)
SP-S 301.451 Famous Contemporary Negroes (15)
SP-S 301.451 Gallery of Great Afro-Americans (50, Color, Manual)
SP-S 301.45 Modern Negro Contributors (24)
SP-S 301.45 20th Century Americans of Negro Lineage (24, Map, Manual)

HISPANIC HISTORY

Films

MPF 398900 How Man Discovers His Past (Col, 20 min) (modern Mexicans, Aztecs, older groups; shows Dr. Jose Angula exploring the agricultural techniques of the Teotihuacans)
MPF 566700 Mexico's History (16 min)
MPF 563050 Mexican-American Heritage and Destiny (Col, 29 min)
MPF 563050 Mexican-American Heritage and Destiny (Col, 29 min) (in Spanish)
MPF 437100 Indians in the Americas (Col, 16 min)
MPF 163100 Civilization of Ancient America (Col, 22 min) (Mayan, Aztec, Olmec, Inca)
MPF 666300 Peru: Inca Heritage (Col, 17 min)
MPF 067000 Aztecs (Col, 11 min)
MPF 233200 Early American Civilizations (Mayan, Aztec, Incan)
MPF 433800 Incas: Ancients of the Andes (Col, 11 min)

Filmstrips

Fs 972.01 Aztec Achievements in Art and Science
Fs 972.01 Maya Achievements in Art and Science
Fs 980.3 Inca Achievements in Art and Science
Fs 980.3 Inca Culture and Highlands Indians (62 Fr)

Soundstrips

Ss 301.2 Mexico (3 Rec, 6 Fs, Manual)
Ss 301.45 Minorities Have Made America Great, Mexican-Americans, Set E (Fs, Rec)
Ss 917.2 Industrial Revolution in Mexico

Study Print

SP-S 301.453 Spanish-Speaking Americans

ASIAN HISTORY

Films

MPF 105800	Born Chinese, Part I (30 min)
MPF 105801	Born Chinese, Part II (27 min)
MPF 151550	China Today (Col, 22 min)
MPF 462200	Japan (Col, 25 min)
MPF 462400	Japan, Copy B (Col, 27 min)
MPF 462600	Japan, An Historical Overview
MPF 541300	Manzanar (impact of relocation camps on Japanese-American families)

Filmstrip

Fs 915.2	Art and Architecture in Japan (39 Fr)

Soundstrips

Ss 301.45	Minorities Have Made America Great, Japanese and Chinese, Set D (Fs, Rec)
Ss 301.45	Chinese-Americans (Fs, Cass, Manual)

AMERICAN INDIAN HISTORY

Films

MPF 026700	American Indians: Before the White Man (Col, 19 min)
MPF 026800	American Indians of Today (Col, 16 min)
MPF 437100	Indians in the Americas (Col, 16 min)
MPF 767633	A Nation Within a Nation (includes a Navajo physicist working at the Los Alamos Scientific Laboratory)
MPF 233500	Early Man in North America (Col, 12 min) (includes explanation of how rare objects are examined)
MPF 163100	Civilization of Ancient America (Col, 22 min) (Mayan, Olmec, Aztec, Inca)
MPF 666300	Peru: Inca Heritage (Col, 17 min)
MPF 067000	Aztecs (Col, 11 min)
MPF 233200	Early American Civilizations (Mayan, Aztec, Incan)
MPF 433800	Incas: Ancients of the Andes (Col, 11 min)

Filmstrips

Fs 972.01	Aztec Achievements in Art and Science
Fs 972.01	Maya Achievements in Art and Science
Fs 980.3	Inca Achievements in Art and Science
Fs 980.3	Inca Culture and Highlands Indians (62 Fr)

Soundstrips

Ss 301.2	First Americans: Culture Patterns (4 Fs, 4 Cass, Manual)
Ss 301.45	Minorities Have Made America Great, American Indian, Set C
Ss 970.1	American Indians Before Columbus (4 Fs, 2 Cass, Manual)

Study Print

SP-S 970.1 Contemporary American Indian Biographies (16, Manual)

COMPARATIVE CULTURES

Film

MPF 733700 Right to Be Different (Col, 29 min) (American subcultures, including Blacks, Chicanos, Navajos)

Soundstrip

Ss 301.2 Comparative Cultures: Japan, Navajo Indians

CONTRIBUTING CULTURES, SOCIOLOGICAL INFLUENCES, ANTHROPOLOGY

Films

MPF 030400 Ancient Egypt (Col, 11 min) (includes scientific discoveries)
MPF 241200 Egypt: Cradle of Civilization (Col, 11 min) (includes contributions in architecture, medicine, astronomy, and math)
MPF 558000 Medieval Times: Role of the Church (Col, 14 min) (includes influence on scholars)
MPF 224675 Dr. Leakey and the Dawn of Man, Part I (Col, 25 min)
MPF 224676 Dr. Leakey and the Dawn of Man, Part II (Col, 26 min)
MPF 958250 Who Discovered America? (Col, 14 min)
MPF 586200 Moslem World: Beginnings and Growth (Col, 11 min) (historical and cultural development, shows contributions to western culture in literature, agriculture, chemistry, math and industrial arts)
MPF 025100 America, America (29 min) (diversity of American society, recurrent problems among immigrant groups; highlights problems unique with present-day minorities)
MPF 984950 Yanomana--A Multidisciplinary Study (Col, 43 min) (describes field techniques and findings of teams from such disciplines as human genetics, anthropology, dentistry, linguistics, and medicine as they conduct a study of primitive tribes of Venezuela and Brazil)

GENERAL

Films

MPF 120800 Calendar: Story of Its Development (Col, 11 min)
MPF 170200 Color of Man (Col, 11 min)
MPF 399000 How Man Learned to Count (30 min)
MPF 615050 Nobody Goes There: Ellis Island (9 min) (foreign population in the United States

MPF 969450 Women's Prejudice Film (Col, 18 min)
MPF 172400 Common Fallacies About Group Differences (15 min)
MPF 428600 Immigration in America's History (Col, 11 min) (includes contributions of different groups)

Soundstrips

Ss 301.243 Living with Technology: Can We Control Applied Science? (Col, 5 Fs, 5 Cass, Manual)
Ss 301.243 Science and Society: Reconciling Two Perspectives (Col, 6 Fs, 6 Cass, Manual)
Ss 301.45 Minorities Have Made America Great, Part II (6 Fs, 6 Rec, Manual)
Ss 301.45 Minorities Have Made America Great, Set A (Col, 2 Fs, 2 Rec, Manual)
Ss 301.45 Minorities Have Made America Great, Set B (Col, 4 Fs, 4 Rec, Manual)

Cassette

Cass 325.73 They Chose America: Conversations with Immigrants (6 min)

Study Prints

SP-S 925 Men of Science (20, Col)
SP-S 615.66 Blood and Blood Plasma Transfers

SCIENTIFIC AND MEDICAL CAREERS

Films

MPF 146200 Chemistry and a Changing World, 2nd Edition (11 min) (shows a research chemist at work)
MPF 130700 Careers: Health Services (Col, 11 min)
MPF 130800 Careers in Agriculture (14 min) (includes research, conservation)
MPF 131000 Careers in Engineering (Col, 15 min)
MPF 131550 Careers: Technicians (Col, 12 min)
MPF 248200 Electronics, the Future, You (Col, 12 min)
MPF 258600 Engineering: A Career for Tomorrow (Col, 22 min)
MPF 343200 Getting Acquainted with Engineering (Col, 23 min)
MPF 456050 Is a Career in the Health Services for You? (Col, 16 min)
MPF 456055 Is a Career in the Professions for You? (Col, 16 min) (includes health services)
MPF 456065 Is a Career in the Social Sciences for You? (Col, 15 min) (includes geographer, anthropologist)
MPF 636825 Other Women, Other Work (Col, 20 min) (includes veterinarian, marine biologist)
MPF 658400 Pathways to the Future (30 min) (research careers)
MPF 969250 Women in Careers (Col, 15 min)
MPF Agribusiness: Environment, Fine Arts and Humanities, Marine Science (Col, 22 min, 4 Films)
MPF Rx: Information, the Health Sciences (Col, 12 min)

Filmstrip

Fs 371.42 Dentists and Other Medical Occupations

Soundstrips

Ss 371.42 Careers in Health (4 Fs, 3 Cass, Manual)
Ss 371.42 Careers in the World of Computers (3 Fs, 3 Cass, Manual)
Ss 371.42 Education in Engineering and Applied Science (Col, 2 Fs, 1 Rec, Manual)
Ss 371.42 Health, Environment, Marine Sciences (3 Fs, 3 Cass)
Ss 371.42 Health Careers (Col, 2 Fs, 2 Rec, Manual)
Ss 371.42 People Who Work in Science (4 Fs, 4 Cass, Manual)

Cassette

Women in Science (6 Cass, slides and written summaries) (includes one Black and one Chinese scientist)

OTHER SOURCES

Billy

Designed to interest Indian young people in medical careers; available from the American Association of Indian Physicians, 1300 McGee Drive, Suite 103, Norman, Oklahoma 73069

Code Blue (27½ minutes, color)

A dramatic film designed to motivate Black and other minority groups to consider a career in medicine or allied health occupations. Hospital delivery room activities are woven into an articulate discussion by young Black people and Chicanos on the need for minority representation in health manpower; available on loan from The Modern Talking Picture Service, 1145 N. McCadden Place, Los Angeles, California 90038; #4409

What About Tomorrow (28 minutes, color)

This film dramatizes the search of a Black youth for identity and a life goal. The portrayals are of young people caught up in the pressures of racial consciousness and social change, but yet striving to be successful. Career opportunities for Blacks in dentistry and the dental needs of the disadvantaged community are emphasized; available on loan from the Modern Talking Picture Service, 1145 N. McCadden Place, Los Angeles, California 90038; #4291

A Matter of Opportunity (27 minutes)

This film focuses on the many opportunities available to students who decide on a career in medicine; produced specifically for members of minority groups; available from the Modern Talking Picture Service, 1145 N. McCadden Place, Los Angeles, California 90038; #3882

A Better Life

Edited by Chicanos, Indians; available from the Sandia Laboratories, Motion Picture Division, Albuquerque, New Mexico 87115

In Our Native Land

Edited by Southwest Indians (one scientist, one nurse, one Ph.D); available from the Sandia Laboratories, Motion Picture Division, Albuquerque, New Mexico 87115

They Did It, So Can You (filmstrip, cassette)

Interviews with four engineers--one Indian, one Black, one Mexican-American, one Puerto Rican; available from The Minority Engineering Education Effort, Inc., 345 Bart 47th Street, New York, NY 10017

SUGGESTED TOPICS FOR REPORTS AND DISCUSSIONS

1. Strong evidence exists that Africa was the birthplace of humanity. Report on the discoveries leading to this conclusion, comparing them to those made in other countries. Comment on Richard Leakey's speculation that his discovery of a one and one-half million year old homo erectus (define and tell about others) skull in Africa may cause scientists to add up to a million years to the age of China's "Peking Man." Describe the potassium-argon radioactive decay process used to date Leakey's find and compare it to previously used dating techniques. Discuss how the concept of Africa as the cradle of humanity affects theories of racial inferiority or superiority. Speculate as to why minorities who immigrated or came to America developed in a different direction and at a different pace than those who remained, if indeed they did. Trace the spread of humanity from Africa to the rest of the world.

2. Several cultures influenced the directions taken by Hispanic science through the centuries. Name and date them and discuss their respective roles and contributions (Roman, Moslem, Jewish, Spanish Christian, Old World, New World, Indian, Immigrants, Natives). Discuss the interplay among the Moslems, Jews, and Christians and the factors encouraging or limiting their roles in science. Describe the effect each had on the other's science. What factors decided the dominant Hispanic sciences and affected the spread of science during each historical era? Discuss the roles played by Christian beliefs about the finiteness of life; the role of churchmen in science; science as a tool of the oppressors; the spreading of the gospel; Moslem pilgrimages to Mecca; love of luxury; fatalism; love of knowledge (both ancient and new); the Jews' access to Moorish knowledge, educational level, command of languages (show how Arabic terms thus entered our language); growing isolation from the mainstream as Moorish influence slackened and Christian influence grew. How did the need to fill the royal treasury, spread the empire, and explore affect the course of Spanish science?

3. Why are American Indians called the first true environmentalist or ecologists? How did the following factors affect this--heritage, conditions in America, religious beliefs and practices (compare with those of the Biblical Jews)? Compare their ideas and practices with those being urged by modern ecologists.

4. Name the five Hispanic and five Asian Nobel Prize winners and briefly describe them and their work. Or, do an essay in depth on one of them, discussing their background, work, contributions, and the forces which molded them. (Study the ingredients of a good biography before starting.) How did racism affect their lives--if it did?

5. Trace the use of tools from Africa to the rest of the world, commenting on (a) the use of "as is" natural materials (sticks, stones, etc.) as tools; (b) the idea that the use of tools differentiated humans from their ancestors--noting that rough tools older than any known human life have been found and that some animals are known to use tools; (c) the deliberate shaping of tools (stone knives, arrowheads, mortars, etc.); (d) the development of general purpose tools; (e) the development of special purpose

tools; (f) the addition of handles to tools; (g) how environment, needs, beliefs, materials on hand, *etc. affected the development of tools*; (h) the independent development of tools in different countries (similarities and differences); (i) the recently announced possibility that quartz or quartzite chopping tools found in the Nihowan Basin of Northern China may be the oldest known human tools; and (j) the powering of tools.

6. Discuss and compare the pyramids and mounds of Ethiopia, Egypt, Mexico, North America, China, Greece, Italy, India, and Assyria--and their builders. Comment on the construction and purposes of these structures and on modern discoveries made about them. Some scientists believe there was communication between the early Egyptians and the Aztecs; others, that African tribesmen reached the New World long before Columbus. If so, the building of pyramids and mounds might have spread from one part of the world to another rather than having developed independently in each country. What do you think? Why?

7. The Stone Age cultures--one Mongoloid, one Negroid--of North America and Africa developed along often similar lines. Discuss the similarities and point out the conditions--environmental, religious, health, etc.--which lead to them. How would you explain the differences? The similarities? (Include agriculture, metal making and working, tools, pottery, taming of animals, irrigation, fertilization, herbal and "superstitious" medicine).

8. Compare the early Asian, Black, American Indian, and Hispanic cultures in regard to their development and understanding of astronomy--and their belief in astrology. (Compare also that of the builders of Stonehenge). How did their contributions in astronomy--especially those of the Chinese and Japanese--affect that of today? Why do you think so many early cultures studied the heavens? What factors affected belief in astrology? Discuss Isidore of Seville's distinction between natural and superstitious astrology--and the scientific basis, if any, for these beliefs. Astrology is enjoying a renewed popularity today. Why do you think this is happening? Can you draw any parallels between the ancient cultures and our modern one that might account for this belief? Do you believe in astrology? Why, or why not?

9. Compare the early mathematical knowledge of the four groups listed in this book, and the factors influencing their use of numbers. Discuss their counting systems, their base numbers, the factors affecting the study of pure math.

10. Classification--of plants, soils, meteors, meteorites, animals, drugs, clouds, etc.--was a major step in the development of science. Discuss each group's efforts in this direction, commenting on the amazing sophistication and continuing usefulness and validity of many of their listings.

11. The early Moslems and Egyptians were especially fond of luxury. How did this affect the course of their science?

12. Compare the scientific and medical roles played by women in each of these cultures, discussing the cultural and religious factors which dictated their roles throughout history. If they were influential, was theirs a direct or indirect role? How is the situation for them now?

13. Write an essay detailing a full day in the life of an American family. Underline each product or scientific or medical technique mentioned and tell which culture contributed to it (individual foods, space flight, medical transplants, transportation of frozen foods, portable x-rays, the ticket and change machine at the theatre, rubber tires, toothbrush, gold fillings, fire extinguishers, telephone, electric lights, low cost shoes, gas mask, folding bed, ironing board, grass receiver for lawn mower, wheelbarrow, seismograph, etc.) Make the point that "No man is an island unto himself" and discuss how progress depends on all people. There is speculation that the large size and physical and mental health of the average American resulted from the good diet and health habits learned from the Indians. Do you think this is true? Why? (Remember that the average European in Columbus' day was only five feet tall and that one out of every ten suffered a severe mental or physical disability.) Discuss, in addition, the Indians' contribution to our form of government.

14. Sarah Breedlove Walker (Madame C. J. Walker) became a millionaire by creating special cosmetic products for Black women--among them a straightening comb and a hair softener. Discuss why these products were so popular in Madame Walker's time and why she would probably have to find another line of work today.

15. Discuss how racism and prejudice hampered Ely Parker, Dr. Charles Drew, Dr. Ernest Just, Matthew Henson, Ishi, and Alberto Houssay. How did this hurt or how might it have hurt the rest of the world? Comment also on how these attitudes and conditions may have actually helped or strengthened the person affected.

16. Athletic ability has opened previously locked doors or made easier the road of many minority scientists, among them Dr. Charles Drew, Dr. Delano Meriwether and Mr. T. S. Ary. Why? Is this true today? Why? Why not? What other careers and/or avocations have traditionally been more open to minorities? Why? (Include those considered acceptable for women.)

17. Compensatory, bilingual, and integrated education are among the approaches being advocated for today's minority students. Some people advocate a blending of cultures that allows the retention of certain ethnic characteristics and practices; some the total retention of their separate culture and language; some, full absorption by the dominant culture. Discuss the pros and cons of these approaches, giving your opinion of which would enable each group to develop best and which would make it easiest and most effective to encourage minority members to enter the sciences. How would each approach limit and/or benefit students? Ethnoscience--the teaching of science to minority students by relating it to aspects of their culture--is also advocated. Discuss this approach, too.

18. What common factors made the great building feats of early civilizations possible, i.e., the Great Wall of China, the Grand Canal of China, the pyramids and mounds found in many countries, etc.? Discuss whether this stage of history--when people were expendable and rulers had absolute authority--was essential in the growth of civilization. Do you think growing consciousness of the "wrongness" of this sacrifice of life and lack of freedom led to the development of "people-saving" inventions and

new scientific/religious/governmental concepts? Was this a necessary stage (as many contend war was) for populations with limited resources and no birth control? (Many Indians used birth control and most had a great reverence for life. Many were democratic in their political practices. Find out if these traits were common to the Mound Builders and discuss the above question in that light.)

19. Discuss and compare the educational, governmental, and religious restrictions which have hampered different groups at different times in history. Factors which might be included are the closing of Japan to the outside world; the role of the Meiji government; Indian reservations; and government schools for Indians (including the effect of sending Indian children to boarding schools); wartime internment of Japanese-Americans; slavery; the beliefs and restrictions of Spanish Christianity; the relationship between explorers/conquerers and native people, etc. What still needs to be done today in this area? Discuss also the effect of cultural "taboos" (i.e. against the touching of the dead) on minority members of a majority culture.

20. In 135 B.C. Han Ying noticed that all snow flakes are six-pointed. How do you think he did that without a microscope? DeEnrico noticed a difference in the level of Atlantic and Pacific Oceans in the late 1400's or early 1500's. How was this possible in the absence of modern equipment? Read the story of the development of corn by the Indians. How do you think they achieved this? Do you think it proves their civilization was the earliest one? How do you think the Indians learned to extract edible products from poisonous plants?

21. Compare the making of paper in different cultures. Discuss the materials used and describe how paper affected each civilization. How was knowledge recorded and passed on in each culture before paper came into use?

22. Read and discuss the introductory comments ("Importance of Recognizing the Contributions of...") to each chapter. Do you agree with the ideas presented? Why? Why not? How are things changing? Why? What effect will these changes have?

23. Discuss Sequoyah's development of a written language and the progress that resulted from this. Compare this to the development of some other language to show just how remarkable his achievement was.

24. Discuss the effect of censorship on the growth of science. Show which cultures it has affected and what form it took. This could include the idea that "the reading of heathen books leads to an increase in the sin of pride"; religious and government censorship (the Inquisition, Calvinism, the idea that curiosity is akin to heresy, government determination of "acceptable" material, restriction of knowledge by class, etc.); the book *Fahrenheit 451*; the idea that some races or groups are better at learning certain kinds of information than others; things "suitable" for women to know or for "mixed" conversation; refusal of a government to allow students to study in other countries; the very idea that one person or group can and should decide what another person or group should read or know. Discussion might also include the "human" tendency to shy away from the new

or different and the funding of scientific work in accord with the needs or wants of the funding agency.

25. What was "the greatest chemical achievement of medieval times"? Why? Who made it? Select another major achievement and compare the long-term effects of the two.

26. Many Renaissance scientists were dilletantes, studying science for fun. Why? What effect did this have on medicine, surgery, different branches of science?

27. Jose De Acosta was called the Pliny of the New World. Why? Discuss the works of both.

28. In many early civilizations (i.e. the Incas) the leaders were left free to pursue intellectual topics. Compare this to the present-day situation in different countries and to the frequently advanced idea that society should be run by its scientists. Discuss the good and bad points of each. Discuss the social responsibilities of scientists, engineers, and doctors.

29. The laryngoscope--and, indirectly, the medical specialty in which it is used--was invented by a music teacher. Can you think of other scientific or medical advances made by people in other fields?

30. Ibn Ezra, the great Toledo-born Jewish philospher, writer, and mathematician, was immortalized in Robert Browning's "Rabbi Ben Ezra." Compare Browning's portrait of this man with the standard stereotypes of scientists. Compare science and its role in society with the popular attitudes toward science and different group's views of science (past and present).

31. Compare the Navajo Star legend of Coyote and First Man with the Big Bang theory of George Gamow. Compare the myths of planting corn and beans together and of talking to plants with today's ideas. Compare the "walking of the Pollen Path" with the ideas of today's environmentalists.

32. Read the story of Dr. Marigold Linton and discuss the motivating factors she cites as responsible for her success. Do you agree or disagree with these ideas? What other factors do you feel are important?

33. Read the story of Kirmach Natani and discuss the concept of serendipitous accidents--of being in the right place at the right time. Can you think of other such events which have affected the course of science?

34. Compare the medicine of the East and the West; in earlier days and now. We are seeing an upswing in acceptance of such Asian practices as acupuncture. Why do you think this is happening?

35. Select a discovery, an invention or a concept (or a person) from this book and show how your life, your parents' lives, and society have been affected by it.

36. Define various scientific and medical fields. Compare their past and present aspects. Discuss the interplay of various fields. Show how one

person's work fits or doesn't fit into the modern definition of a field. What's involved in working in a certain field? How do you prepare to enter a given field?

37. The chapter on Blacks lists some of the many inventions. Take a look at these and others (the Negro Almanac contains a lengthy list) and speculate on the reasons Blacks were responsible for so many inventions.

38. In Dinah L. Moché's *Women in Science* (Part I), mention is made of Dr. Chien Shiung Wu's early education (starting at the age of 10) in a government-run boarding school in China (She had to win admission to this school). Dr. Wu is quoted as saying that her years there were "happy and educational" and that the experience of living apart from her family helped prepare her for her later departure from China. Compare her experiences and reactions with those negative ones often reported by Indian students separated from their families and placed in government boarding schools. Speculate on the factors possibly responsible for these differing reactions.

Suggested Approaches for Question and Answer Sessions

1. What do you think of? Why?
2. What might have happened if? Why?
3. What does it mean?
4. What did you learn?
5. What would you like to know?
6. How can you find out?
7. Who did what? When? How? Why?
8. Do you agree? Disagree?
9. How does this affect me? What do I want? How can I achieve it?